National

National Shoreline Study

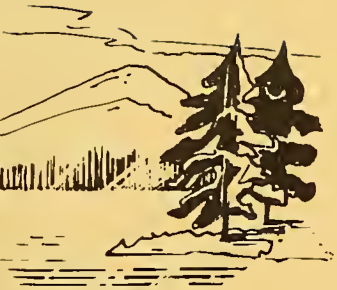
Pg 30-34

Regional Inventory Report

NORTH ATLANTIC REGION

Volume I

U.S. Army Engineer Division, No. Atlantic
Corps of Engineers
New York, N.Y. 10007
1971



The National Shoreline Study

How will the shore be used ?

SEE

SHORE MANAGEMENT GUIDELINES

What is its condition ?

SEE

REGIONAL INVENTORY REPORTS

What can be done ?

to preserve or enhance the shore,
by using—

- Engineering techniques

SEE

SHORE PROTECTION GUIDELINES
REGIONAL INVENTORY REPORTS

- Management techniques

SEE

SHORE MANAGEMENT GUIDELINES

In 1968, the 90th Congress authorized this National appraisal of shore erosion and shore protection needs. This National Shoreline Study and the existing Federal shore protection programs recognize beach and shore erosion as problems for all levels of government and all citizens. To satisfy the purposes of the authorizing legislation, a family of 12 related reports has been published. All are available to concerned individuals and organizations in and out of government.

REGIONAL INVENTORY REPORTS (one for each of the 9 major drainage areas) assess the nature and extent of erosion; develop conceptual plans for needed shore protection; develop general order-of-magnitude estimates of cost for the selected shore protection; and identify shore owners.

SHORE PROTECTION GUIDELINES describe typical erosion control measures and present examples of shore protection facilities, and present criteria for planning shore protection programs.

SHORE MANAGEMENT GUIDELINES provide information to assist decision makers to develop and implement shore management programs.

REPORT ON THE NATIONAL SHORELINE STUDY, addressed to the Congress, summarizes the findings of the study and recommends priorities among serious problem areas for action to stop erosion.

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NATIONAL SHORELINE STUDY
REGIONAL INVENTORY REPORT, NORTH ATLANTIC REGION
AUGUST 1971

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Inquiries regarding a particular reach should be addressed as follows:

Reaches 1 to 4
Norfolk District Corps of Engineers
803 Front Street
Norfolk, Virginia 23510

Reach 5
Baltimore District, Corps of Engineers
P. O. Box 1715
Baltimore, Maryland 21203

Reaches 6 to 11
Philadelphia District Corps of Engineers
Customhouse, 2nd & Chestnut Streets
Philadelphia, Pennsylvania 19106

Reaches 12 to 23
New York District, Corps of Engineers
26 Federal Plaza
New York, New York 10007

Reaches 24 to 33
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

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A.

INTRODUCTION

A. INTRODUCTION

Authority. The National Shoreline Study was authorized by Section 106 of the River and Harbor Act of 1968 as described in Public Law 90-483 and approved 13 August 1968. This legislation resulted from increased concern in shoreline erosion as a result of growing demand for shoreland, increasing erosion and shorefront damages, lack of progress under existing beach erosion control law, and national sensitivity to environmental problems.

Purpose and Scope. The study is an appraisal investigation of the Atlantic, Gulf, and Pacific Coasts of the United States and the coasts of Puerto Rico, the Virgin Islands and the Great Lakes, including estuaries and bays thereof. The study will (1) determine areas where significant shoreline erosion occurs; (2) identify areas where erosion presents a serious problem with respect to economic, industrial, recreation, agricultural, navigational, demographic, ecological, and related values, thus indicating that action to halt such erosion may be necessary soon; (3) describe generally the most suitable type of remedial action for critical erosion areas; (4) provide state and local authorities with information and recommendations to assist in the creation and implementation of state and local shoreline erosion programs; and (5) develop guidelines for land use regulations in coastal areas.

The results of the study are presented in three separate reports each treating one or more of the specific objectives previously listed.

General. The three reports developed for the National Shoreline Study are (1) regional inventories, (2) shore protection guidelines and (3) shore management guidelines. Individual regional inventories are compiled for each region in the United States while shore protection and shore management guidelines are assembled on a national basis.

Some of the objectives of the National Shoreline Study are treated to a degree in this regional inventory report; however, a more complete and detailed account of shore management and shore protection guidelines is found in the two previously mentioned volumes written specifically for these respective purposes.

The Regional Inventory Report. Preparation of the Regional Inventory Report for the North Atlantic Region depended heavily on available information. Collection and processing of new physical data were minimized, and the judgment of experienced personnel was used as a major resource. The assistance of various Federal and non-Federal government agencies as well as civic and conservation groups was solicited to obtain imput information for the report. The data presented in this report therefore are a composite of information obtained from several sources. The report contains inventories and statements of problems without conclusions and recommendations for specific projects or construction.

This report—the regional inventory for the North Atlantic Region—includes information pertaining to the shorelines located in the ten states between the North Carolina-Virginia state line and the Canadian border as shown on plate 1. The study area mainly covers the outer seacoast of the region and includes shores of bays and estuaries such as Chesapeake Bay, Delaware Bay, Delaware River entrance and the large inner bays landward of the barrier beaches where erosion is likely to be a problem.

Information on the ten-state study area has been broken down into 33 coastal reaches which are listed in the table of contents and designated on plates 5 and 6. The report is divided into two volumes, one containing the text and another containing photographs and plates. It is intended that this arrangement will permit reading the text while facilitating convenient reference to the photographs and the plates.

Particular emphasis is placed on the physical descriptions and shore histories of the coast-

lines in the region. The regional shoreline is examined to determine where significant erosion is occurring. Federal projects designed to improve the quality of our coastal areas and studies to determine the needs of specific localities are described and tabulated. Conceptual improvement methods for critical erosion areas, and shore protection programs devised by state and local governments, are presented.

Shore areas undergoing significant erosion and where action to halt erosion may be justified are categorized as critical shore erosion areas. The selection of the critical erosion areas is largely based on qualitative analysis and some exercise of judgment giving careful consideration to economic, industrial, recreational, navigational, demographic, ecological and other relevant factors. If consideration of these factors indicated that management to prevent or minimize adverse effects may be more appropriate than action to halt erosion in certain areas undergoing significant erosion, then those areas were categorized non-critical.

Conceptual plans for suitable remedial action along with approximate costs of protection are presented for areas categorized critical shore erosion. These conceptual plans do not consider the implications of land ownership; they simply show the type of protection considered suitable. There were many areas in the region where minimal engineering data were available from which to formulate plans of shore protection and construction cost estimates. In those cases a gross appraisal, consistent with the purpose and scope of the National Shoreline Study, was made to determine suitable methods of shore protection and to develop construction cost estimates which represent an approximate order of magnitude.

The remedial measures suggested in this report for the critical shore erosion areas would require further study to seek balance in meeting environmental and developmental needs. In this connection, a significant study on the effects of engineering on coastal ecology is being sponsored by the Corps of Engineers in conjunction with university consultants. Their recommendations may affect the implementation of many future shore protection projects. A report titled "Effects of Engineering Activities on Coastal Ecology" was issued by the Corps in September 1969 in which a team of consultants proposes a program to make an overall analysis of the problem, identify research and special studies which will be required, and conduct or advise on such studies.

Shoreline erosion in the North Atlantic Region is due to both natural and man-made effects. The principal factors in shoreline erosion are damage by hurricanes and other storms, shoreline construction affecting beach processes, and the lack of a natural dependable supply of beach nourishment material to keep the shore in a stable condition. Erosion problems are many and varied in the region because the shoreline itself varies from rocky bluffs in the north to large expanses of low, sandy beaches from Southern New England to Virginia. Of some 8,600 total miles of shoreline considered in this report, about 1,100 miles (13 percent) are categorized critical erosion areas. Natural littoral processes are generally adding little material to the shorefront, and loss by erosion is essentially permanent.

Technology is available to counter erosion and protect the shoreline; however, the proper solution must be matched with local conditions. Methods that have been developed and practiced for protection of the coastline are of two general types: (1) Restoration of beaches by initial sand fill and stabilization by subsequent periodic placement of sand to increase the available rate of supply of sand. This may include sand bypassing across inlets to nourish the downdrift shores. There is a critical need to conserve—or acquire—sand for beach nourishment by practical means. (2) Structures to protect against wave action and currents to reduce the energy reaching erodible material and to control shifting due to littoral forces

(e.g., groins, bulkheads, seawalls, revetments, and breakwaters).

Under existing Federal laws, beach erosion control projects constructed with Federal assistance are limited to shores in public ownership or public use, unless the erosion damage is attributable to Federal navigation works. Privately owned shores, not in public use, can be protected by such projects only if the protection is incidental to, or necessary for, the protection of public property. Additionally, Public Law 99, 84th Congress, authorizes the Corps of Engineers to act in flood and coastal storm emergencies to protect, repair, and restore Federally authorized hurricane and shore structures. Information on assistance by the Corps of Engineers in shore protection is given in a pamphlet titled "Shore Protection Program" issued by the Office, Chief of Engineers in June 1971. Assistance programs provided by the States in the North Atlantic Region are summarized in table 2 at the end of this Inventory Report. Progress has been slow under present Federal and State policies.

Recreation is the largest scale use of the region's coastline. Of some 6,000 miles (excluding about 2,600 miles of undeveloped coast) over 3,600 miles, or 60 percent, are devoted to public and private recreational uses. Shoreline recreation in the region is particularly important because of the concentration of population in the area which nearly coincides with the northeast "Megalopolis." Public access to the shorefront and the provision of recreation-related facilities seem to be priority problems for the future, and will require imaginative thinking and renovation of existing laws, policies, and administrative organization and practices to provide the kind of institutional structure that will be responsive to these problems.

Ownership of the region's shore is predominantly private, totalling almost 7,200 miles. Non-Federal publicly-owned shore is around 10 percent of the total coastline. Most of the Federal ownership is represented by Arcadia National Park in Maine, Cape Cod National Seashore in Massachusetts, Fire Island National Seashore in New York, Assateague Island National Seashore in Maryland and Virginia and a number of wildlife refuges, all administered by the U.S. Department of the Interior. Under consideration is a proposal to establish a National Recreation Area at the gateway to New York Harbor.

A shoreline classification summary containing information on physical characteristics, historical shore changes, shore ownership and shore use is presented in table one at the end of the report.

Coordination. The Division Engineer, North Atlantic Division, Corps of Engineers had the responsibility for managing and coordinating the preparation of this Regional Inventory Report. The following Corps offices played an important supporting role in developing input data for the report covering the coast within the area of their jurisdiction: New England Division, New York District, Philadelphia District, Baltimore District and Norfolk District. The staff of the Norfolk District provided invaluable assistance in assembling and consolidating the data provided by the other Corps offices, and arranging for the printing of the report.

Copies of a draft of the Regional Inventory Report were furnished to each State in the region for review. The comments and suggestions received were carefully considered in revising the draft and preparing the final report.

The cooperation of numerous local, State and Federal agencies is acknowledged.

The Federal agencies involved are: National Park Service, Fish and Wildlife Service, Department of Agriculture, Soil Conservation Service, National Ocean Survey, Bureau of Outdoor Recreation, Department of Housing and Urban Development.

The state and local agencies involved are: Southeastern Virginia Regional Planning Commission; Division of State Planning and

Community Affairs, Virginia; Virginia Institute of Marine Science; Board of Supervisors (all coastal counties in Virginia); Maryland Geological Survey; Delaware State Planning Office; New Jersey Department of Conservation and Economic Development; New Jersey State Department of Environmental Protection; New York State Department of Environmental Conservation; New York State Office of Planning Coordination; Nassau-Suffolk Regional Planning Board, New York; Westchester County Planning Board, New York; Department of Parks, City of New York; State Water Resources Commission, Connecticut; State Department of Natural Resources, Rhode Island; State Department of Natural Resources, Massachusetts; State Department of Resources and Economic Development, New Hampshire; State Planning Office, Maine.

B.

DESCRIPTION OF COASTAL AREAS

B. DESCRIPTION OF COASTAL AREAS

1. VIRGINIA-CAROLINA LINE TO ISLE OF WIGHT COUNTY LINE

Physical Chracteristics. The Atlantic Ocean, Chesapeake Bay, and Hampton Roads frontage of this reach encompasses 70 miles of diversified shoreline of which 52 miles are sandy, 4 miles marshy, and 14 miles developed to the waters edge. The reach is shown on plates 5 and 7. Moving northward from the North Carolina state line, a narrow undeveloped barrier strip of land with a sandy beach facing the Atlantic Ocean on one side and several picturesque bays on the other extends a distance of 9 miles before approaching the rapidly developing resort area of Sandbridge Beach. This relatively undisturbed zone varies in width from .25 mile to 1.5 miles and is frequently breached by both sound and ocean waters during storm periods. Access to this area is limited to vehicles capable of traveling on sand since no paved roads exist.

North of Sandbridge to Rudee Inlet, a distance of 4.4 miles, the beach narrows and is separated from the mainland by low dunes. Beach grasses have been planted along sections of this reach in an attempt to stabilize the ever shifting sands.

From Rudee Inlet to Cape Henry, a distance of 7 miles, a flat unstable sandy beach 100 to 200 feet wide and averaging 5 feet mean sea level in elevation is visited annually by more tourists than any resort beach in Virginia. Photographs V-1 and V-2 show this area. The 3.3 miles of shoreline between 49th Street and Rudee Inlet are devoid of dunes while the 3.8 miles between Cape Henry and 49th Street are characterized by an irregular dune line. The 21-mile strip of beach from Cape Henry to just inside Willoughby Spit fronts the Chesapeake Bay and is characterized by an irregular dune line with a beach width varying from 100 to 125 feet at an average elevation of about 5 feet mean sea level. The dune elevation is generally about 12 feet mean sea level. Segments of this reach near the western tip have, of necessity, been stabilized with timber groins.

The remaining stretch of shoreline in this reach, facing Hampton Roads and Willoughby Bay, extends a distance of 21 miles before reaching the Isle of Wight County line. This strip is essentially developed to the waters edge and shows no significant beach area.

There are three tidal inlets along the shoreline in this reach. They are Little Creek, Lynnhaven, and Rudee Inlet. Little Creek and Rudee Inlets are structurally stabilized.

Shore Ownership. Between Sandbridge Beach and the North Carolina state line, the 12 miles of beach are divided among Federal, public, and private interests. Sandbridge Beach, a reach of 3 miles, is publicly owned. The 4.4-mile segment from Rudee Inlet to Sandbridge Beach is largely occupied by the U.S. Anti-Air Warfare Training Center at Dam Neck. A segment of publicly owned beach does, however, exist immediately south of Rudee Inlet.

The 3.3 miles of beach between 49th Street and Rudee Inlet are publicly owned and constitute the most significant ocean front area of Virginia Beach in terms of mass recreational use and commercial development.

The 2.7-mile segment between 49th Street and 89th Street, known as North Virginia Beach, is centered about 3 miles south of Cape Henry and is publicly owned. The U.S. Army's Fort Story extends along the Atlantic Ocean for a distance of about 1.1 miles from 89th Street to a point opposite Cape Henry Lighthouse which is the south point of Chesapeake Bay.

The 21-mile stretch of shoreline from Cape Henry to just inside Willoughby Spit encompasses two military reservations, Little Creek Amphibious Base and Fort Story; the Seashore State Park, and the resort beach of Ocean View. Of the shoreline composing Ocean View, 4 miles are owned privately and 5 miles publicly.

Of the remaining shoreline, 12 miles are Federally owned, 3 miles are publicly owned and 6 miles privately owned.

Of the total shore length of 70 miles, 25 miles are Federally owned, 28 publicly owned, and 17 privately owned. Shore ownership is shown on plate 8.

Shore Use and Development. The shoreline south of Sandbridge is generally undeveloped and publicly used for recreation. The Back Bay Wildlife Refuge and the Little Island Municipal Park are located in this reach.

Sandbridge Beach is privately used for recreational purposes and developed for summer residence. North of Sandbridge to Rudee Inlet, development is primarily military, the U.S. Anti-Air Warfare Training Center being found here. The stretch of shore north of Rudee Inlet to Fort Story is publicly used for recreational purposes. In 1970, the annual visitation at the Virginia Beach resort areas was 4,320,000 persons. Development is residential and commercial.

The 21-mile strip of beach from Cape Henry to just inside Willoughby Spit is used extensively for public and private recreation. Several miles of non-recreational shoreline are devoted to the Little Creek Amphibious Base.

From the U.S. Naval Station to the Isle of Wight County line, the shore is essentially privately used and developed. Residential development accounts for approximately 3 miles of shore, military and industrial development for 16 miles of shore and 2 miles remain undeveloped.

Of the entire reach, 21 miles are Federally developed, 18 miles are privately developed, 18 publicly developed, and 13 undeveloped. Shore use and development are shown on plate 8.

Future Development. Summer residential development south of Sandbridge is expected to continue. Some additional development as parks and conservation areas is likely.

Littoral Drift. A nodal point dividing two littoral drift cells is believed to exist along the Atlantic shoreline in this reach. Observations indicate that south of False Cape, an area approximately 25 miles south of Cape Henry, the drift is southerly. North of False Cape, the drift has a net northerly component. The rate and volume of drift in this zone is relatively large. Drift west of Cape Henry to Willoughby Spit is westerly. Rates in this zone are moderate to small. No information on drift west of Willoughby is available.

2. ISLE OF WIGHT COUNTY LINE TO NEW KENT COUNTY LINE, VIRGINIA

Physical Characteristics. The Hampton Roads, Chesapeake Bay, James River, and York River frontage of this reach encompasses approximately 179 miles of shoreline and is shown on plates 5, 7, and 9. The counties of Surry, Isle of Wight, James City and York and the cities of Hampton and Newport News are located in this reach.

Moving west along the banks of the Isle of Wight and Surry counties, bluffs ranging from 5 to 60 feet in height as well as large expanses of marshland border the James River. Narrow beach zones, interspersed along this strip, total only 5.5 miles.

Crossing the James and following the river east along James City County, Newport News, and Hampton, the shoreline varies from inaccessible marshland to heavily developed frontage.

The 22 miles of shoreline in James City County facing the James River are almost totally inaccessible. There are no beach zones and marshland accounts for approximately 75% of the coastal frontage.

The 33 miles of Newport News shoreline are fairly linear in outline, include 16 miles of marshland, and have several man-made beaches. The banks are characteristically vertical varying in height from 5 feet to 25 feet. Photograph V-6 shows a beach area along the Newport News shoreline.

Hampton, with 21 miles of coastal land facing the Chesapeake Bay, Hampton Roads,

and several rivers, exhibits reaches of marsh, sandy beach, and fully developed shoreline.

York County shoreline, 29 miles in length, faces the Chesapeake Bay and York River and is very irregular, being incised with numerous small waterways and channels. No natural beaches are found along the shores. Practically this entire length is bordered with tidal flats and marshland.

The northern shoreline of James City County fronting the York River totals 8 miles and is similar to the counties along the James River shoreline. Being composed mostly of marshland and tidal flats, the area is relatively inaccessible. It also lacks adequate highways.

Shore Ownership. The majority of the shoreline in this reach is privately owned. Tracts of Federal and public land do, however, exist. These include Tylers Beach in the Isle of Wight County, the State Waterfowl Refuge at Hog Island, and Chippokes State Park in Surry County, Camp Wallace Military Reservation and the Colonial National Historical Park and Parkway, Camp Peary Naval Reservation, and York River State Park in James City County, Fort Eustis in the City of Newport News, Buckroe Beach in Hampton, and Plum Tree bombing range in York County. Of the total shoreline in this reach, ownership is about 39 miles Federal, 30 miles public, and 110 miles private as shown on plates 8 and 10.

Shore Use and Development. The southern shoreline of the James River remains mostly in its natural state, being undeveloped and generally inaccessible.

Isle of Wight County, Burwells Bay, Mogarts Beach and Goodwin Point have small clusters of privately owned beach homes, but aside from these regions the rest of the shoreline is uninhabited.

In Surry County the 2 miles of shoreline at Chippokes State Park (Cobham Bay) are used for public recreation. At Cobham Wharf, Scotland, Pleasant Point and 1 mile north and south of Sunken Meadow Point, there are small groups of private houses and summer cottages, these areas having the only limited beach zones in the county. The remaining 21 miles are undeveloped.

The northern shoreline of the James River shows more diversity in shore use. The City of Hampton shoreline alone, facing the Chesapeake Bay, has an uninhabited beach zone in its northern region; a residential zone at Buckroe Beach; and a military reservation along its southern frontage.

The Hampton Roads-James River shoreline, including Mulberry Island (Fort Eustis), is highly developed. This region includes the Newport News Shipbuilding and Dry Dock Company, as well as many other industries and residential homes.

Mulberry Island is a military reservation, its shoreline consisting mostly of marshland.

The only beaches in Newport News are man-made and generally very small in size.

James City County shoreline is undeveloped and generally inaccessible. There is a large beach by the ferry landing.

The York County shoreline is generally undeveloped except for military installations and a national parkway. There is a public beach at Yorktown. Shore use and development are shown on plates 8 and 10.

Future Development. Private development of the shores in this reach is expected to continue with residential developments experiencing the largest increases. Industrial development is expected to be largely confined to the Hampton-Newport News areas. No increase in public beaches or facilities is foreseen.

Littoral Drift. Littoral drift in the Chesapeake Bay is generally southerly. The rate of transport is low to moderate depending upon wave environment. Net drift in the rivers generally moves in the direction of Chesapeake Bay.

3. GLOUCESTER COUNTY LINE TO KING GEORGE COUNTY LINE, VIRGINIA

Physical Characteristics. The York River, Mobjack Bay, Chesapeake Bay, Rappahannock

River, and Potomac River frontage of this reach totals approximately 380 miles and is shown on plates 5, 9 and 11. The counties of Gloucester, Mathews, Lancaster, Middlesex, Northumberland, and Westmoreland have shorelines in this reach. Of the total shoreline length, about 110 miles are sandy, 250 miles are marshy, and 20 miles developed to the waters edge. Tangier Island with 5 miles of marshy shoreline, and located in the Chesapeake Bay, is also included in this section.

The York River shoreline is characterized by marshland extending almost its entire length. Small, widely separated clusters of private, residential homes and summer cottages are common near the mouth of the river. The Mobjack and Chesapeake Bay shorelines of Gloucester and Mathews Counties are very irregular in outline, being incised by the Severn, Ware, North, East, and Piankatank Rivers, as well as dozens of lesser rivers and streams. This area is characterized by extensive marshland throughout and totals approximately 100 miles of shoreline.

The Rappahannock River, Chesapeake Bay, and Potomac River frontage found in Lancaster, Richmond, Essex, Middlesex, Northumberland and Westmoreland Counties encompasses 262 miles of shoreline.

Moving along the Rappahannock River through Middlesex, Essex, Richmond, and Lancaster Counties, there are 161 miles of shoreline which include approximately 65 miles of marshland, 29 miles of wooded shore, 46 miles of clear beach, 14 miles of developed waterfront property, and 2 miles of sandy beach.

The Northumberland and Westmoreland County frontage on the Potomac River is 63 miles, including 10 miles of marshland, 2 miles of wooded shore, 36 miles of clear beach, and 16 miles of developed property. Colonial Beach, a recreational beach approximately one mile south of King George, Westmoreland County line, is found in this reach.

Shore Ownership. The majority of shoreline in this reach is privately owned. Tracts of Federal and public land do, however, exist. Shore ownership is shown on plates 10 and 12.

Shore Use and Development. The majority of the shoreline is either inaccessible or undeveloped. Residential development does, however, exist to a limited extent. Few public beaches are found along this reach, with Colonial Beach on the western bank of the Potomac being the most popular. Shore use and development are shown on plates 10 and 12.

Future Development. The shoreline in this reach will continue to develop residentially. No industrial development is foreseen.

Littoral Drift. Littoral drift in the Chesapeake Bay is generally southerly. The rate of transport is low to moderate depending upon wave environment. Net drift in the rivers generally moves toward Chesapeake Bay.

4. EASTERN SHORE AND BARRIER ISLANDS OF VIRGINIA

Physical Characteristics. The Atlantic Ocean, Chesapeake Bay, and interior bay frontage of this reach encompasses 109 miles of sandy shoreline and 255 miles of marshy shoreline, and includes the counties of Accomack and Northampton. This reach is shown on plates 5 and 11.

Moving southward from the Maryland state line on the Chesapeake Bay side, 84 miles of brackish water marshes meander to the mouth of Occohannock Creek. No sandy beaches and very little development exists here.

The 41-mile segment of shore from Occohannock Creek to Cape Charles fronts Chesapeake Bay and is characterized by both marsh and sandy beaches. Where beach does exist, it is characteristically narrow and low. Dunes are not present in this reach.

The 113 miles of mainland shoreline north of Cape Charles is protected from direct oceanic attack by numerous barrier and in-

terior islands and fronts a series of brackish bays. This entire area is characterized by high-salinity salt marshes.

Barrier islands, subject to direct oceanic attack, account for 126 miles of shoreline between Cape Charles and the Maryland state line. The windward shores of these islands are sandy and measure 62 miles. The leeward shores are marshy and measure 64 miles. Islands found in this reach that are accessible by boat only, include Assawoman, Metomkin, Cedar, Parramore, Hog, Cobb, Wreck, Ship Shoal, Myrtle, and Smith. Those accessible by boat and bridge are Assateague, Wallops and Fisherman Island. Just inland, many marsh islets encircled by unique natural channels highlight this area.

Assateague Island has an excellent beach and a luxuriant growth of vegetation in a relatively unspoiled state. The beaches are wide and clean, the foreshore gently sloping. This portion of the island is wider, has higher dunes, and is less subject to breaching than its Maryland counterpart. It is an excellent example of a typical Atlantic seacoast.

Parramore Island is the longest in the chain of coastal islands lying off the Virginia Eastern Shore. The island is relatively unspoiled and its beach offers excellent opportunities for bathing, surf casting, and other forms of seashore recreation. Some vegetation exists on the island.

Hog Island is almost a barren strip of sand, 6 miles long and less than one mile wide. The lower half of the beach is filled with stumps of trees and bordered with piles of dead tree trunks and bushes. Vegetation is sparse; there are some scrub trees and bushes well back from the beach.

Directly south of Hog Island is Cobb Island. It is less than 6 miles in length and almost devoid of vegetation. The beach is wide and fairly clean and the foreshore dips rather sharply into the sea.

Wreck Island, south of Cobb Island, is characterized by low and unstable dunes, with indications that this island has been washed over many times. There is no high, firm ground on the island.

Ship Shoal Island lies directly south of Wreck Island and is similar in character.

Wallops Island possesses some sizeable portions of forested land, narrow beaches, a few dunes, and evidences of erosion. Just south of Wallops Island lies Assawoman, similar in character but with less cover.

A slender, finger-like island, south of Assawoman, Metomkin Island exhibits very little vegetative cover, narrow beaches, and unstable dunes.

Cedar Island, lying northeast of Wachapreague, has wide sandy beaches and some good tree and shrub cover.

Myrtle Island has luxuriant vegetation in spots and has narrow, washed over beaches.

Smith and Fisherman Islands possess narrow beaches and luxuriant vegetation in spots. The islands are low and subject to frequent breaching. Fisherman Island is shown in photograph V-16.

Shore Ownership. The entire mainland shore of this reach is privately owned. Ownership of the barrier islands is as follows. All are privately owned except Fisherman, Wallops, and Assateague islands which are Federally owned; Wreck Island, Mackhorn Island, Parkers Marsh and Saxis Wildlife Management Area which are State owned. Shore ownership is shown on plate 12.

Shore Use and Development. Except for a few small coastal towns, the entire shoreline of this reach is undeveloped. The marsh reaches, while of high ecological significance, receive limited human usage due to the limited extend of shoreline development in nearby mainland areas as well as restricted accessibility. Sandy shores along the Chesapeake Bay are occassionally used for recreation. There is one public municipal beach at Cape Charles town. The beach at Assateague National Seashore is long, wide and public. The beach northward from there to the Maryland state line is also open to the public, although it is a part of the

Chincoteague National Wildlife Reserve. Windward shores of the barrier islands are privately used for recreational purposes by owners. Shore use and development are shown on plate 12.

Future Development. Recent studies initiated by private and Federal interests have suggested the possibility of Barrier Island development. However, no extensive development of those islands or the fringing marshlands is anticipated.

Littoral Drift. Although no quantitative data are available, observations indicate that drift moves predominantly from north to south. Quantities and rates are moderate to heavy on the windward side of barrier islands.

5. MARYLAND

Physical Characteristics. This reach, as shown on plates 5, 13, 15, 17 and 19, includes the shoreline of Chesapeake Bay and its tidal tributaries lying within the State of Maryland from near Havre de Grace in the upper Chesapeake Bay to the Maryland-Virginia boundary line. It also includes Maryland's 31 miles of coastline along the Atlantic Ocean and its inner bays.

All of Maryland's tidewater counties lie within the Coastal Plain Province. Depending upon the location, the shorelands are composed of Quaternary-age gravel, sand, silt, clay and peat, Tertiary-age sand, clay, silt, green sand and diatomacious earth; and Cretaceous-age gravel, sand, silt, and clay.

On the Bay proper, the shoreline is fronted generally by a shallow water belt more than 1,000 feet wide before the 6-foot mean low water depth contour is encountered. From the 6-foot contour outward, the depth increases at a more rapid rate. In Maryland, the width of the Chesapeake Bay ranges from 3 to 16 miles north to south, and averages about 8 miles. Across this body of water, maximum mean wind velocity ranges from 11 miles per hour at Aberdeen in the north, to 15 miles per hour at Patuxent in the south, from the direction of NNW to WNW. Maximum percentage frequency of occurrence is from the northwest, and ranges from 10 to 18 percent of the year. Hurricane winds have been recorded up to 75 miles per hour, with gusts up to 97 miles per hour.

The shoreline of the Bay is indented by many tributary estuaries and streams. The largest tributary estuaries are the Patapsco, Potomac, and Patuxent Rivers on the Western Shore,and the Chester, Choptank, and Nanticoke Rivers on the Eastern Shore. The shoreline along the Bay proper totals 280 miles, with the Western Shore having 154 miles and the Eastern Shore having 126 miles.

The shoreline of Chesapeake Bay and its tidal tributaries consists generally of banks and bluffs ranging in height from a few feet above high tide to over 100 feet in Calvert County. Of Maryland's total detail shore length of over 4,000 miles, an estimated 1,939 miles are vulnerable to erosion and are considered in this report. About 15 miles have year-round sandy beaches. The shoreline along lower Eastern Shore Counties—Somerset, Wicomico, and Dorchester—however, is predominantly marsh.

The coast of Maryland is comprised of portions of the barrier islands—Fenwick and Assateague along the Atlantic Ocean. Ocean City, an intensely developed commercial resort, occupies the entire nine-mile reach of Fenwick Island in Maryland and extends from the Maryland-Delaware line to the Ocean City inlet. About 22 miles of Assateague Island lie in Maryland, extending from the inlet to the Maryland-Virginia boundary line. The topography of the islands is generally represented by marsh on the bay side and sand dunes on the ocean side.

Shore Ownership. Nearly all of the shore frontage in Chesapeake Bay is privately owned. There is, however, extensive frontage in Federal ownership, principally at Department of Defense installations at Aberdeen Proving Grounds and Edgewood Arsenal, both in

Harford County; the Naval Academy at Annapolis; and the Patuxent Naval Air Station at the mouth of the Patuxent River. In addition, Assateague Island is being purchased by the National Park Service for a National Seashore.

The State of Maryland owns parks at Sandy Point near Annapolis, Elk Neck and the Gunpowder River in the upper Bay, Point Lookout at the mouth of the Potomac River, Cliffs of Calvert, in Calvert County, James Island in Somerset County, Purce in Charles County, and at St. Clements Island in the Potomac River. The State also owns and operates a park along a two-mile reach on Assateague Island. The City of Baltimore owns frontage at Fort Smallwood, a city park near the mouth of the Patapsco River.

Of the total shoreline of 1,939 miles, ownership is about 225 miles Federal, 35 miles non-Federal public, and 1,679 miles private. Shore ownership is shown on plates 14, 16, 18, and 20.

Shore Use and Development. Because of its convenience to the metropolitan areas of Baltimore and Washington, D.C., much of the Western Shore of Chesapeake Bay is developed for residential use, generally for summer occupancy, but also for year-round use in the immediate vicinity of the population centers. Industrial development is concentrated in the Baltimore area on the Patapsco River. The Eastern Shore of the Bay consists primarily of farmland waterfronts. Of the Chesapeake Bay and Atlantic Coast inner bay shoreline, about 80 miles are considered public recreational, 105 miles as private recreational, 1,623 miles as non-recreational development, and 100 miles as undeveloped.

The attendance at various park facilities in the Chesapeake Bay during Fiscal Year 1970 is as follows:

Sandy Point State Park	520,000
Elk Neck State Park	434,700
Gunpowder State Park	380,500
Point Lookout State Park	161,900
St. Clements Island	Not available
*Fort Smallwood	112,000
Calvert Cliff State Park	23,700
James Island State Park	99,500
Purce State Park	Not available

*Attendance is for calendar year 1970.

Ocean City is Maryland's most popular resort, accommodating nearly 13 million visitors in 1969. The city is intensely developed with motels, apartments, restaurants, and other commercial activities typical of an ocean resort. About 3 miles of coastline in Ocean City is considered as public recreational with the remaining 6 miles considered as private recreational. Assateague Island, Maryland, on the other hand, is undeveloped except for the area near the bridge which has State and Federal camping facilities. The entire 22-mile coastline is considered as public recreational. Shore use and development are shown on plates 14, 16, 18, and 20. Approximately 1,020,000 people visited the State Park on Assateague Island in Fiscal Year 1970; the Federal portion of the park in Maryland attracted 823,000 visitors in 1970.

Future Development. The Western Shore of the Bay will continue to develop residentially with increasing development in Southern Maryland. The Eastern Shore will also be subjected to increasing residential developments with the counties near the William Preston Lane, Jr., Memorial Bridge (Talbot and Queen Annes) experiencing the largest increases. Industrial development is expected to be largely confined to the Baltimore Metropolitan area.

Ocean City will continue to be developed as a commercial resort. Because of the shortage of oceanfront lots and the increasing concern over the filling of marshland on the Bay side, an increasing number of high-rise apartments can be expected to be built. Assateague National Seashore and the State Park on Assateague Island will be developed along noncommercial lines.

Littoral Drift. Wave action in Chesapeake Bay is light except during storms. In general, the most severe wave action is from the northeast

which causes a southerly littoral drift. The rate of littoral transport is low. Generally, coarser grain sediments are found near the shore of the Bay with grain size diminishing toward the central or deeper parts of the main channel. In the Bay, recent bottom sediments as a whole consist of 50 percent soupy to sticky clay and silt and 50 percent sand, which ranges from very fine to coarse.

Along the ocean, the predominant littoral drift is southerly. It is estimated that an average of 150,000 cubic yards annually move southerly along the coast of Ocean City and that an average of 400,000 cubic yards annually move along the coast of Assateague Island.

6. CAPE HENLOPEN TO FENWICK ISLAND, DELAWARE

Physical Characteristics. The Atlantic Ocean Coast of Delaware extends for about 24.5 miles from Cape Henlopen at the entrance to Delaware Bay southward to the Delaware-Maryland state line at Fenwick Island. The entire shore length in this reach, shown on plates 5 and 21, has a beach zone. A 7.5-mile section in the central portion of the ocean frontage consists of a narrow barrier beach separating Rehoboth and Indian River Bays from the ocean. About 5.5 miles to the south, a 3.5-mile section of narrow barrier beach separates Little Assawoman Bay from the ocean. The remaining reaches of ocean beach front on the mainland. One inlet, protected by stone jetties, cuts through the barrier beach at Indian River Bay.

The 2.7 miles of ocean frontage from the tip of Cape Henlopen southward to the end of the Fort Miles Federal Military Reservation consists of wide sandy beaches backed up by low artificially built dunes or natural irregular dunes ranging up to 60 feet in height.

From the boundary of the Military Reservation south to Rehoboth Beach, a distance of about 2.7 miles, the beach consists of a wide sandy strip separating the ocean from tidal marshes and flat sands to the rear. The ocean frontage of Rehoboth Beach totals approximately 1.7 miles and consists of a beach generally 100 feet wide fronting a boardwalk. The beach slope averages 1 on 10. Photograph D-4 shows the beach condition at Rehoboth Beach. Adjoining Rehoboth Beach to the south, the community of Dewey Beach has an ocean frontage of 1.3 miles. This area is fronted by dunes with a gently sloping beach approximately 150 feet wide between the toe of the dune and the mean high water line.

Between Dewey Beach and Bethany Beach for a distance of about 7.5 miles, a barrier beach one-quarter to one mile in width separates the ocean from Rehoboth and Indian River Bays. Most of this area is maintained as a State Park. The beaches in this reach are 50 to 200 feet in width, and are backed by a belt of grass-covered sand dunes averaging several hundred feet in width with maximum heights of 25 feet. Photograph D-3 shows the beach condition in the vicinity of the Indian River Inlet which occurs in this reach.

To the south of this reach is the municipality of Bethany Beach with a total frontage of one mile. The beach in this area is generally narrow and is backed by very low dunes. Photograph D-2 shows the beach condition in this area. The shorefront between Bethany Beach and Fenwick Island at the Delaware-Maryland state line includes the Assawoman Wildlife area and a state park. The area consists of a barrier beach and marsh about one-half mile wide separating the ocean from Little Assawoman Bay. The beaches are relatively wide and are backed by dunes up to several hundred feet in width and 25 feet in height. Photograph D-1 shows the beach condition at Fenwick Island.

Shore Ownership. The length of shore frontage in this reach totals 24.5 miles. Ownership is divided as follows:

	Miles	% of Total
Federal	1.0	4
Public (Non-Federal)	17.3	71
Private	6.2	25
Total	24.5 miles	100%

Locations of reaches of shore by type of ownership are shown on plate 22.

Shore Use and Development. Of the total ocean frontage of 24.5 miles, approximately 12.3 miles consist of state parks and conservation areas. The Fort Miles Federal Military Reservation occupies about one mile of ocean frontage. The remainder of the shore consists of non-Federal public and private properties. About 6.6 miles of the ocean frontage consists of residential developments serving permanent populations as well as summer residents. Virtually the entire reach of ocean shore is open to public recreation. Annual attendance for recreational use in this reach is 1,460,000. The following tabulation is a summary of shore use and development.

Shore Use	Miles	% of Total
Recreational - Public	20.8	85
Recreational - Private	2.7	11
Non-Recreational Development	1.0	4
Total	24.5	100%

Reaches of shore by type of use are shown on plate 22.

Future Devopment. Continued construction of new motels and summer cottages is expected in the resort areas. Continued increases in commercial activities directed toward accommodating visitors seeking recreation and amusement are also anticipated. Wider use of the parks by the increasing population will also require improvements in the existing facilities and further recreational development in these areas.

Littoral Drift. Accretions of sand along the south side of the south jetty at Indian River Inlet and along the northside of the North jetty at Ocean City Inlet, Maryland indicate that a nodal area exists in the 20-mile reach between these inlets. The groins at Bethany Beach show accretion on the south side in summer and on the north side in winter, with the net accretion indicating a slight northerly littoral drift. It is believed that the nodal area is not fixed and that it is in the vicinity of Bethany Beach. North of Bethany Beach the net littoral movement is to the north, while south of Bethany Beach the movement is to the south.

The rates of littoral movement are moderate. It is believed that the principal sources of accretion at Cape Henlopen are the eroding beaches to the south. Since 1843, approximately one-third of the eroded beach material has been deposited on the cape. The remaining two-thirds has apparently been deposited on the shoal areas offshore of the Cape.

7. REHOBOTH, INDIAN RIVER AND LITTLE ASSAWOMAN BAYS, DELAWARE

Physical Characteristics. The shorelines of Rehoboth, Indian River and Little Assawoman Bays consist mostly of marshlands with short reaches of narrow sandy beaches occurring in some areas. The following tabulation summarizes the physical characteristics of the shorelines of these three bays. The reach is shown on plates 5 and 21.

	Shore lengths (miles)		
Bay	Marsh area	Beach area	Total
Rehoboth Bay	46	2	48
Indian River Bay	34	11	45
Little Assawoman Bay	26	1	27
Total	106	14	120

Shore Ownership. The length of shore frontage in this reach totals 120 miles. Ownership is divided as follows:

	Rehoboth Bay	Indian River Bay	Little Assawoman Bay
Federal	0	0	0
Public (non-Federal)	2.0	1.0	12.0
Private	46.0	44.0	15.0
Total	48.0	45.0	27.0

Locations of reaches of shore by type of ownership are shown on plate 22.

Shore Use and Development. The publicly owned and the developed reaches of privately owned shores are used mainly for recreation. An environmental study of Rehoboth, Indian River and Little Assawoman Bays by the joint efforts of the natural resources and planning agencies of the State of Delaware dated November 1969 revealed that between 1938 and 1969 the length of shoreline development increased from 0% to 25% (12 miles) in Rehoboth Bay, from 9% to 44% (16 miles) in Indian River Bay and form 0% to 10% (3 miles) in Little Assawoman Bay. The development includes miles of dredged lagoons and hundreds of acres of marsh fill. Considerable lengths of bulkhead were constructed to retain the marsh fill in some areas. Annual attendance for recreational use is not available for this reach. The following tabulation summarizes the available data on shore use and development.

	Shore lengths (miles)				
	Recreational		Non-Recreational		
Bay	Public	Private	Development	Undeveloped	Total
Rehoboth Bay	2	10	0	36	48
Indian River Bay	1	19	0	25	45
Little Assawoman Bay	*	3	0	24	27
Total	3	32	0	85	120

*State Conservation area at Little Assawoman Bay includes about 10 miles of undeveloped shoreline.

Reaches of shore by type of use are shown on plate 22.

Future Development. Much of the shoreline is currently under development and there is more in the planning stages. During a ten months period in 1969, the Water and Air Resources Commission received 23 applications for permission to bulkhead and backfill 2,785 feet of shoreline. During that same period, applications for dredging 3,600 feet of navigation channel averaging 50 feet in width and 8 feet in depth were received. In addition to these private operations, the State was considering (in 1969) the dredging of a total of 918,000 cubic yards from 5 creeks tributary to the bays. Disposal would be mostly on marsh areas.

For ecological reasons, the above mentioned environmental study recommended that the State acquire strategic portions of the shorelines in the three bay areas to prevent private encroachment and to help preserve the bays. A prior report dated June 1967 by the Delaware State Planning Office entitled, "Preliminary Comprehensive Development Plan," recommended that most of the shoreline area of the three bays be preserved as part of a plannned open space area.

Littoral Drift. The quantity of littoral drift in motion along the shores of the inland bays is believed to be low. Where erosion of the

shoreline has occurred, it has usually been due principally to the action of storm or wind generated waves and currents, rather than to a continual process of erosion by littoral forces. Some areas adjacent to deep channelized reaches, such as along the shores west of the inner (bay) end of the Indian River Inlet, do experience progressive erosion partly due to the daily action of tidal currents.

8. DELAWARE RIVER AND BAY SHORE OF DELAWARE CAPE HENLOPEN TO WILMINGTON

Physical Characteristics. The shoreline in this reach, shown on plates 5, 23, 25, and 27, totals 81.5 miles. The 49.0-mile reach of shore north of Pickering Beach consists mainly of marsh areas and poorly drained low areas with fairly extensive sections of mud flats which are exposed at low tide. In the 32.5-mile reach south of Pickering Beach, marshes and low flat lands are separated from the Delaware Bay by a fairly continuous narrow strip of sandy beach. Of the total 81.5 miles of shore, approximately 37.6 miles consist of sand beach, while the remainder has virtually no beach zone. Photographs Nos. D-5 through D-8 show the condition of the beach at Broadkill Beach, Primehook Beach, Bowers and Pickering Beach, respectively.

Shore Ownership. Shore ownership is divided as follows:

	Miles	% of Total
Federal	11.0	13
Public (non-Federal)	14.0	17
Private	56.5	70
Total	81.5	100%

Locations of reaches of shore by type of ownership are shown on plates 24, 26, and 28.

Shore Use and Development. Annual attendance for recreational use in this reach is 350,000. This figure includes only Pickering Beach, Kitts Hummock, Bowers Big Stone Beach, Slaughter Beach and Primehook Beach. The following tabulation summarizes the shore use and existing development:

	Miles	% of Total
Recreational - Public	9.0	11
Recreational - Private	0	0
Non-Recreational Development	1.8	2
Undeveloped	70.7	87
Total	81.5	100%

Reaches of shore by type of use are shown on plates 24, 26, and 28.

Future Development. A preliminary comprehensive development plan for the State of Delaware (mentioned in reach 7 of this report) proposes preservation of nearly all of the remaining marsh areas and low lands along the shores of the study area as planned open space areas. Development in these areas is not expected. However, continued development is expected in the existing residential areas, particularly in the eight existing recreational communities between Pickering Beach and Lewes.

Littoral Drift. There is very little movement of littoral drift in the reach north of Pickering Beach as evidenced by the lack of sandy beaches. Along the sandy reaches to the south, however, there is a moderate to low movement of drift. Accretions at the southeast side of groins at Slaughter Beach and Broadkill Beach and at the northwest side of the northwest jetty at Roosevelt Inlet indicate that a nodal area exists in the reach between Broadkill Beach and Roosevelt Inlet. The location of the nodal point is not fixed, but varies with changing conditions of wind, tides, and waves.

9. DELAWARE RIVER AND BAY SHORE OF NEW JERSEY CAPE MAY POINT TO PENNS GROVE

Physical Characteristics. The greatest portion of the Delaware Bay shoreline consists of salt marshes and meadows, often extending inland

for several miles. The salt meadows are always waterlogged during the growing season, though rarely entirely covered at high tide. The salt marshes are covered at high tide with six inches or more of water during the growing season. Of the 75 miles of shore between Salem and the Cape May Canal, 75 percent or approximately 56 miles of the Bay shore consists of such wetlands, while a sparse 12 miles are in residential development. The remaining 7 miles are devoted to commercial and industrial use. The residential developments are generally fronted by narrow sandy beaches. The total frontage of the study area between Penns Grove and Cape May Point consists of 48 miles of wetlands and areas without beaches and 37 miles of beach. This reach is shown on plates 5, 29, 31, and 33. Photographs NJ-1 through NJ-4 show typical beach conditions at Thompson's Beach, Moores Beach, Reeds Beach and Wildwood Villas, respectively.

Shore Ownership. About half of the shore frontage between Penns Grove and Cape May Point is privately owned. Shore ownership is divided as follows:

	Miles	% of Total
Federal	23	27
Public (non-Federal)	19	22
Private	43	51
Total	85	100%

Locations of reaches of shore by type of ownership are shown on plates 30, 32, and 34.

Shore Use and Development. The greatest portion of the Delaware Bay shore is vacant land, consisting primarily of salt marshes and meadows. Included among these marshlands are several State and Federal public hunting and fishing areas. Wildlife and waterfowl inhabit the marshes. Fishing and crabbing along the Salem County (above Stow Creek) and Cumberland County (between Stow Creek and West Creek) bay shores are mostly of a commercial nature, while more recreational fishing activities are found in Cape May County (below West Creek). The magnitude of the fishing industry is, however, rather limited. The oyster industry in Cumberland County has a significant impact on the economy of the State of New Jersey as well as on the immediate bay area. The oyster industry is on the road to recovery following a disastrous invasion of a fungus parasite in 1958 which severely affected the oyster crop.

Residential developments along the bay shore are scattered throughout the area. These are usually fronted by narrow sandy beaches whose recreational use is generally limited by extensive offshore mud flats. Because of the physical limitations, these beach areas have not been fully developed and, in many instances, are not used for bathing. Annual attendance for recreational use is not available in this reach.

The extent of shore use and development is summarized in the following tabulation and are shown on plates 30, 32, and 34.

	Miles	% of Total
Recreational - Public	61	72
Recreational - Private	0	0
Non-Recreational Development	2	2
Undeveloped	22	26
Total	85	100%

Future Development. The bay shore of New Jersey has not experienced the extensive development characteristic of the State in its role as the "most urban State" in the Nation. There are no apparent signs that such extensive development is imminent. The nature of the land precludes development directly up to and including the actual bay frontage. The existing bay front communities for the most part are constructed on fill dumped into the marshes. This type of required construction is not economically sound for extensive urban or industrial development since suitable sites inland are abundant. However, although extensive urban or industrial development of the bay shore is not expected in the immediate future, the value of the shore front for recreation and conservation purposes is of recognized

importance. The bay frontage provides an excellent location for satisfying a portion of the recreational needs of New Jersey, especially with regard to hunting and fishing. In addition, its potential as a wildlife preserve is of value to the State as a whole.

Littoral Drift. Littoral drift is generally insignificant along most of the bay shore. The quantity of drift feeding existing beaches is generally low, with the possible exception of the area in the vicinity of the Cape May Canal entrance where the supply of drift is moderate.

10. ATLANTIC COAST OF NEW JERSEY MANASQUAN INLET TO CAPE MAY POINT

Physical Characteristics. The ocean coast in this reach, as shown on plates 3, 35, 37, 39, and 41, consists mostly of long, sandy barrier islands separated from the mainland by tidal marshes, bays, creeks, and lagoons. A number of inlets separate the individual islands and provide for the exchange of tidal flow between the ocean and back bays. The entire shore length of 97 miles has a beach zone.

The barrier island between Bay Head and Barnegat Inlet (23.2 miles in length) is characterized by high dunes varying in top elevation between +14 and +29 feet m.l.w. Beach slopes in the zone between mean low water and +10 feet m.l.w. vary between 1 on 8 and 1 on 24. In the zone below mean low water, the slopes of the bottom out to the 15-foot to 30-foot depth contour generally vary between 1 on 20 and 1 on 35. Photographs No. NJ-17 and NJ-18 show beach conditions at Lavaletta and Bay Head, respectively. The barrier island of Long Beach Island (20.0 miles in length) is characterized by dunes with top elevations of between +15 and +20 feet m.l.w. Berms fronting the dunes are generally less than 100 feet wide with elevations of about +8 to +10 feet m.l.w. Beaches fronting the berms slope at about 1 on 40 to about 15- and 20-foot depth contour. Photograph No. NJ-16 shows the beach condition at Holgate near the lower end of the Island. At Brigantine Island, (5.8 miles in length) dunes rise to about +15 feet m.l.w. with beach slopes of about 1 on 60 from mean high water to the 15-foot m.l.w. depth contour. (See photograph No. NJ-13.) On Absecon Island, (8.0 miles in length) berms averaging 300 feet wide at about +8 feet m.l.w. occur at Atlantic City, with beach slopes generally flatter than 1 on 35 between mean high water and the 8-foot m.l.w. depth contour. Along the remainder of this island, the beaches fronting the communities of Ventnor, Margate and Longport have slopes of 1 on 20, rising to an elevation of about +10 feet m.l.w. at the bulkheads in this reach. Photograph Nos. NJ-11 and NJ-12 show typical beach conditions at Longport and Ventnor, respectively. Beach slopes along Peck Beach (7.6 miles in length) average 1 on 30 to about the 6-foot m.l.w. depth contour. Photograph No. NJ-10 shows the beach condition at Ocean City at the north end of Peck Beach. Ludlam Beach (6.9 miles) and Seven Mile Beach (7 miles) are characterized by dunes fronted by narrow to moderately wide berms and beach slopes of about 1 on 30. Photograph No. NJ-9 shows the beach condition at Strathmere near the north end of Ludlam Beach. Photograph No. NJ-8 shows the beach at Stone Harbor on Seven Mile Beach. The beaches at the Wildwoods (5.0 miles in length) are wide with slopes of about 1 on 30 above mean low water and 1 on 80 below mean low water to about the 10-foot m.l.w. depth. From Cold Spring Inlet to the western limit of Cape May City, the beach slope above mean low water is 1 on 30 and is considerably flatter below m.l.w. Photographs Nos. NJ-5, NJ-6, and NJ-7 show the condition of the beach at Cape May Point, Lower Township, and Cape May City, respectively. Beach slopes at Cape May Point are relatively steep, averaging 1 on 12 to about the 5-foot m.l.w. depth.

Shore Ownership. Ownership of the 97-mile length of shore is divided as follows:

	Miles	% of Total
Federal	8.1	8
Public	65.7	68
Private	23.2	24
Total	97.0	100%

Locations of reaches of shore by type of ownership are shown on plates 36, 38, 40, and 42.

Shore Use and Development. Most of the habitable land in this reach, except for a few isolated beach front areas, has been developed primarily for recreational purposes. The development provides for a wide variety of housing accommodations for both visitors and permanent residents. Major resorts, having appreciable commercial facilities, are Atlantic City, Ocean City, and the Wildwoods. Other areas such as Long Beach Island, Sea Isle City, and Cape May are primarily residential. Annual attendance for recreational use is 52,500,000 in this reach. Shore use is divided as follows:

	Miles	% of Total
Recreational - Public	87.5	90
Recreational - Private	0	0
Non-Recreation Development	0	0
Undeveloped	9.5	10
Total	97.0	100%

Reaches of shore by type of use are shown on plates 36, 38, 40, and 42.

Future Development. Continued development is anticipated with the increasing population. Expansion of existing facilities to satisfy the demand by the increasing number of visitors as well as permanent residents is likewise anticipated. Development of parks and conservation areas is also expected.

Littoral Drift. The net direction of littoral drift in the reach below Barnegat Inlet is to the southwest (downcoast), due primarily to the predominance of wave activity from the northeast quadrant. Due to the shielding effect of Long Island, New York, wave activity from the northeast quadrant is significantly reduced in the reach to the northeast of Barnegat Inlet. The result is the creation of a nodal zone generally in the reach near Barnegat Inlet. The net direction of the littoral drift in the reaches above Barnegat Inlet is, therefore, to the northeast.

Local reverses in the direction of littoral transport sometimes occur at inlets, where tidal currents intercept the littoral drift. While the gross rate of transport may be considered relatively high, the net rate is moderate. Wave action during storms has been known to move substantial quantities of sand from the beaches and deposit it offshore in depths where the normal littoral forces are generally not sufficient to return all of the material to the beaches.

11. BARNEGAT BAY TO CAPE MAY HARBOR, NEW JERSEY

Physical Characteristics. The shoreline of the tidal bays and lagoons separating the barrier islands from the New Jersey mainland consist mainly of marshes, bulkheaded lagoon-type developments and short reaches of narrow sandy beaches. Of the total shore length of 240 miles, about 35 miles normally have sandy beaches. Photographs Nos. NJ-14 and NJ-15 show the beach condition on the mainland along the west side of Barnegat Bay at Double Creek. This reach is shown on plates 5, 35, 37, 39, and 41.

Shore Ownership. Ownership of the 240 miles of shore is divided as follows:

	Miles	% of Total
Federal	30	13
Public (non-Federal)	27	11
Private	183	76
Total	240	100%

Locations or reaches of shore by type of ownership are shown on plates 36, 38, 40, and 42.

Shore Use and Development. Much of the bay shore frontage is used for private and public recreation. The Intracoastal Waterway follows the natural channels and deep water reaches in the bays throughout the entire length of this reach between the Manasquan River and the Cape May Canal. Consequently, most of the shoreline development is related to recreational boating. Development along the bay shores of the barrier islands is extensive throughout the entire reach. Along the mainland shores of the bay areas, development is extensive in the reach to the north of and including Great Egg Harbor. Much of this development is of the lagoon type used primarily for private recreational boating. Below Great Egg Harbor, the mainland shore is mostly marshy with little development. Annual attendance for recreational use is not available in this reach. The following tabulation summarizes the shore use and development characteristics.

Shore Use	Miles	% of Total
Recreational - Public	119	50
Recreational - Private	23	10
Non-Recreational Development	1	–
Undeveloped	97	40
Total	240	100%

Reaches of shore by type of use are shown on plates 36, 38, 40, and 42.

Future Development. Continued development of the bay shore areas is anticipated. Most of this development will be related to recreational boating, similar to the lagoon-type of developments common on the shores of Barnegat Bay.

Littoral Drift. Except in the immediate vicinity of the coastal inlets, the quantity of littoral drift along the shores of the bay areas is very low. Where shoreline erosion has occurred, it has usually been due principally to the action of storm or wind generated waves and currents, rather than to a continual process of erosion by littoral forces.

12. SANDY HOOK TO MANASQUAN INLET, NEW JERSEY

Physical Characteristics. This reach, as shown on plates 5 and 43, consists of that portion of the Atlantic Coast of New Jersey to Monmouth County, New Jersey, extending from the northerly extremity of Sandy Hook Peninsula southward to Manasquan Inlet. The shoreline of this reach is about 27 miles in length and comprises about 26 percent of the total ocean frontage of the shore along the Atlantic Coast of New Jersey. There are 14 communities along the shore of this reach entirely in Monmouth County.

The northern portion of this reach consists of a peninsula and a narrow beach extending to Monmouth Beach. The surface of the peninsula is covered with low sand dunes interspersed with low sandy beach ridges. The southern portion of this reach includes a bluff area immediately adjoining the ocean rising to elevations of up to 25 feet above mean sea level, the higher elevations being located along the northern portions of this section.

Shore Ownership. Along this reach the only Federally-owned land bordering the shore is Fort Hancock on the Sandy Hook peninsula. The Federal ands comprise about 22.7 percent of the total length of shore of the reach.

Of the total shore length of about 27 miles, ownership is about 22.7 percent or 6.1 miles Federal, 42.3 percent or 11.3 miles non-Federal public, and 35.0 percent or 9.4 miles private. Shore ownership is shown on plate 44.

Shore Use and Development. This reach is well known for its recreational development and one of the most famous sand spits in the world, known as Sandy Hook. In this reach, shore development is recreational and residential in character with some commerce and industry. Residences along the shore generally consist of high cost residences fronting the ocean. In addition to hotels, there are cottage colonies in

the area for the accommodation of the summer resident population. With the exception of the usual retail trade connected with the permanent population and commercial fishing, the other activities along the shore municipalities are generally of a supporting nature to the recreational activities. Annual attendance for recreation use is 6,940,000 in this reach. Shore use and development are shown on plate 44.

Future Development. Recreational and summer residential development is expected to continue.

Littoral Drift. The accretion at the south sides of groins and jetties and the elongation of Sandy Hook indicate a general predominance of northward drift north of a nodal region between Manasquan and Barnegat Inlets.

13. RARITAN BAY AND SANDY HOOK BAY, NEW JERSEY

Physical Characteristics. This reach, as shown on plates 5 and 43, consists of that portion of shore in Middlesex and Monmouth Counties, New Jersey along Raritan and Sandy Hook Bays between the entrance to the Raritan River on the west and Shrewsbury River on the east. The shoreline of this reach is about 19.9 miles in length. There are 11 principal communities along the shore of the study area.

The terrain of the study area ranges from high bluffs near the west and east ends of the area to low marshlands which are partially inundated by spring tides. The shoreline generally fronted by low narrow beaches is intersected by a number of tidal creeks.

Shore Ownership. Along this reach the only Federally-owned lands bordering the shore are the U.S. Navy Depot and U.S. Coast Guard Conover Beacon Light Station in Middletown Township.

Of the total shore length of 19.9 miles, ownership is about 0.5 percent or 0.1 mile Federal, 32.6 percent or 6.5 miles non-Federal public, and 66.9 percent or 13.3 miles private. Shore ownership is shown on plate 44.

Shore Use and Development. In this reach shore development is primarily residential and recreational in character with some commerce and industry. Residences along the shore are mainly small cottages, many of which are summer dwellings. Commercial and industrial development in this reach include a chemical and miscellaneous manufacturing plant at Union Beach, a fish factory producing fertilizer and fish oils at Port Monmouth, a fuel oil storage terminal at Atlantic Highlands, and the usual retail establishments associated with the local population. A U.S. Navy Depot is located at Leonardo. Recreational boating is a popular activity in this area. There are numerous small piers and bulkheads along the shore including a large marina at Atlantic Highlands to accommodate recreational craft. An amusement center is located in Keansburg. Shore use and development are shown on plate 44.

Future Development. Summer residential development is expected to continue as is development of recreational areas.

Littoral Drift. The supply of littoral drift is limited since only small quantities of sand are trapped at groins. The material that is available is believed to originate from sedimentation of streams, erosion of the shore itself and longshore currents carrying material around Sandy Hook from the Atlantic Coast of New Jersey.

14. FORT WADSWORTH TO ARTHUR KILL, STATEN ISLAND, NEW YORK

Physical Characteristics. This reach, as shown on plates 5 and 45, consists of that portion of Staten Island, New York, extending along Lower New York and Raritan Bays from Fort Wadsworth at the Narrows to Tottenville at the mouth of Arthur Kill entirely within the Borough of Richmond, Middlesex and Monmouth Counties, New Jersey, from the south shore of Raritan Bay and Sandy Hook Bay which is contiguous to Lower New York Bay. The shoreline of this reach is about 13 miles in length.

The terrain of this reach ranges from high bluffs near the east and west limits to low marshlands. The shoreline which is mostly fronted by low beaches of varying width is intersected by several tidal creeks, some of which discharge through gated flumes.

Shore Ownership. Along this reach the only Federally-owned land bordering the shore is at Miller Army Air Field, a satellite of Fort Wadsworth.

Of the total shore length of 13 miles, ownership is about 2.0 percent or 0.3 mile Federal, 69.0 percent or 9.0 miles non-Federal public, and 29.0 percent or 3.7 miles private. Shore ownership is shown on plate 46.

Shore Use and Development. In this reach, shore development is primarily recreational and residential in character with some commerce and industry. Residences near the shore are mostly small cottages, some of which are summer dwellings. Commercial and industrial developments in the study area include a dental manufacturing plant at Princess Bay, boatyards at Princess Bay and Great Kills, and the usual retail establishments associated with the local population. Numerous public and private recreational facilities are found at several locations. South Beach, Great Kills Park, and wolfe's Pond Park owned by the City of New York offers for public use the largest bathing beaches in this reach, and had an estimated annual attendance of about 698,000 persons in 1970. An example of the demand for recreational facilities is shown by the acquisition of the shore between Miller Air Field and Great Kills Park and on both sides of Lemon Creek for park purposes. Shore use and development are shown on plate 46.

Future Development. Residential and recreational development is expected to be continued in this reach.

Littoral Drift. The predominant direction of littoral drift is westward, as indicated by accumulations of material at existing groins and other shore structures.

15. ROCKAWAY INLET TO NORTON POINT, NEW YORK

Physical Characteristics. This reach, as shown on plates 5 and 45, consists of that portion of the New York City shore in the Borough of Brooklyn fronting Lower New York Bay from Rockaway Inlet on the east to Norton Point on the west. The shoreline between these limits is about 5.1 miles in length. This reach is more commonly referred to as Coney Island.

The terrain of the Coney Island area is relatively flat with ground elevations generally less than 10 feet above mean sea level. Except for navigation channels and several previous dredge cuts, shallow water depths of less than 20 feet below mean sea level generally border the reach. There are several sandy beaches along the shore of the reach including Plumb Beach, Manhattan Beach Park, Coney Island Beach, and Sea Gate Beach. Most of the remaining portion of the shore is either riprapped or bulkheaded. Offshore of Coney Island is a large shoal, the East Bank Shoal, which provides a limited measure of protection against ocean wave attack to the more exposed western portion of the reach.

The communities which comprise the Coney Island area include, from east to west, Gerritsen, Sheepshead Bay, Manhattan Beach, Brighton Beach, Gravesend, Coney Island, Bensonhurst, and Sea Gate. The permanent population of the communities in this area is approximately 200,000 persons.

Shore Ownership. In this reach the only Federally-owned shore is a small parcel of land on which the Norton Point Lighthouse stands. The Federal land comprises about 0.3 percent of the total length of shore. The City of New York has title to the following blocks of land which form three-quarters of this shorefront which faces the Atlantic Ocean; Kingsborough Community College; former U.S. Public Service Hospital; Manhattan Beach Park; and Coney Island Beach. The remaining quarter of this shorefront is privately-owned and includes the Manhattan Beach esplanade and Sea Gate

Beach. Access to the City-owned Coney Island Beach and Manhattan Beach Park is available to the public, but access to the privately-owned Sea Gate Beach is restricted to residents of this community. Of the total shore length of 5.1 miles, ownership is about 0.4 percent or 0.02 mile Federal; 68.3 percent or 3.5 miles non-Federal public, and 31.3 percent or 1.6 miles private. Shore ownership is shown on plate 46.

Shore Use and Development. Recreational development and activities predominate along the shore of the study area along with some residential, commercial, industrial, public utility, and educational facility development. The most important recreational development, in terms of size and usage, is the City-owned Coney Island Beach, boardwalk and fishing pier which lie on the south side of the communities of Coney Island and Brighton Beach in the central portion of the reach. Adjacent to the north side of Coney Island Beach and boardwalk are several additional recreational facilities, the New York City Aquarium and several private health resorts. In the community of Manhattan Beach there is an esplanade in poor condition. Manhattan Beach Park is a public beach with supporting recreational facilities. The attendances at Coney Island Beach and Manhattan Beach Park were about 20,121,400 persons and 1,696,700 persons, respectively, during the 1970 beach season.

East of Manhattan Beach Park, there is the vacant U.S. Public Service Hospital and the Kingsborough Community College which occupies the site formerly used by the U.S. Air Force as a reserve training station. On the north side of Manhattan Beach lies Sheepshead Bay which harbors a recreational boating fleet and a sport fishing fleet of substantial size. East of Sheepshead Bay is the Plumb Beach portion of the City-owned Marine Park which is generally undeveloped except for a small picnic area and marina facilities.

West of Coney Island Beach, along the south shore of the adjacent community of Sea Gate, recreational development consists of Sea Gate Beach which is privately owned by the residents of this community. Continuing around the west and north shore of Sea Gate, development is primarily residential with the exception of Lindbergh Park and the Norton Point Lighthouse.

On the north side of Coney Island lies Coney Island Creek which is bordered by recreational facilities such as a marina, the Leon S. Kaiser Playground, and Dreier-Offerman Park, educational facilities, residential and industrial development, public utilities, vacant lots and junk yards. North of Coney Island Creek, along the shore of Gravesend Bay, shorefront development consists of a marina, public utilities, commerce and industry. Shore use and development are shown on plate 46.

Future Development. Considerable redevelopment of the older, more densely developed portions of the area is currently being undertaken. The most extensive redevelopment is occurring in the community of Coney Island where construction of high-rise multi-family apartment houses is replacing much of the existing development which is predominately "old-law" tenements. A large portion of this redevelopment is being financed by the Federal Government under various sections of its urban renewal program which is administered by the U.S. Department of Housing and Urban Development. In anticipation of further redevelopment in Coney Island, New York City has investigated and is considering increasing the minimum elevation of the legal grade system in this community in order to reconstruct a more effective interior drainage system.

Littoral Drift. The predominant direction of littoral drift has, over the long period generally been in a westerly direction, as evidenced by the accumulations of material at existing groins and jetties. However, at Manhattan Beach Park in the easterly part of the reach, the littoral drift is in an easterly direction.

16. EAST ROCKAWAY INLET TO ROCKAWAY INLET, NEW YORK

Physical Characteristics. This reach, as shown on plates 5 and 45, which is in the form of a peninsula, consists of that portion of the Atlantic Coast of New York City extending from East Rockaway Inlet to Rockaway Inlet. This peninsula generally referred to as the Rockaways, separates the Atlantic Ocean from Jamaica Bay immediately to the north. The shoreline of this reach is about 10 miles in length and comprises about 8.0 percent of the total shore frontage of the Atlantic Coast of New York City and the South Shore of Long Island. There are 10 communities along the shore of this reach all entirely within the Borough of Queens.

The terrain of the Rockaway peninsula is low-lying and flat, with elevations generally less than 10 feet above mean sea level. Several gently rolling hills in Far Rockaway rise to elevations of 20 to 25 feet above mean sea level. Shallow water depths of less than 20 feet fringe the ocean shoreline, while the drop-off on the bay side to depths of 30 to 40 feet is much more rapid. The ocean shoreline consists of a continuous beach strip which attains its maximum width at Rockaway Point. A series of groins have been constructed along the beach. A stone jetty has also been constructed off the western tip of Rockaway Point, extending approximately 8,400 feet into the ocean. Sand has naturally deposited to the east of the jetty and in recent years it has caused the extreme westerly portion of the peninsula to increase substantially in width.

Jamaica Bay or the back bay area of this reach is not covered in this report as it contains a great number of tidal marsh islands and hassocks as well as an extensive marsh and wetlands area around its periphery. There are no known erosion problems in the bay area.

Shore Ownership. Along this reach the only Federally-owned land bordering the shore is at the U.S. Military Reservation at Fort Tilden. The Federal land comprises about 10 percent of the total length of shore of the reach.

Of the total shore length of 10 miles, ownership is about 10 percent or 1.0 mile Federal, 70 percent or 7.0 miles non-Federal public and 20 percent or 2.0 miles private. Shore ownership is shown on plate 46.

Shore Use and Development. In this reach shore development is primarily residential and recreational in character with the usual commercial enterprises serving the needs of vacationers. Residences along the shore vary in size from summer bungalows and cottages to high-rise multi-family housing projects. This reach is dominated by the presence of the continuous strip of sandy beach, and a lengthy boardwalk, and a public park. Jacob Riis Park, Rockaway Beach operated by the City of New York offers for public use in the area, bathing and related park beach facilities. The attendance figures of Rockaway Beach and Jacob Riis Park were 21,000,000 persons and 1,372,000 persons, respectively, for the beach season of 1970, which includes the last week of May to the second week of September. Shore use and development are shown on plate 46.

Future Development. With urban renewal under way in the area, residential development is expected to continue as well as recreational and shopping facilities.

Littoral Drift. The direction of littoral drift in this reach is generally westward, as evidenced by accumulations of material at existing groins.

17. SOUTH SHORE OF LONG ISLAND, NASSAU AND SUFFOLK COUNTIES, NEW YORK

Physical Characteristics. The reach consists of that portion of the south shore of Long Island in Nassau and Suffolk Counties, New York, extending from East Rockaway Inlet in the Town of Hempstead to Montauk Point in the Town of East Hampton and is shown on plates 5, 45, 47, and 49. The shoreline of this reach is about 108 miles in length and comprises about

92 percent of the total frontage of south shore of Long Island along the Atlantic Coast. There are 17 villages along the shore of the area in four of the seven towns of Nassau and Suffolk Counties.

The shore area is characterized by a series of narrow barrier beaches, separated from the mainland by a number of tidal bays varying in width from 500 feet to about 5 miles. The width of the barrier beaches is generally less than 2,500 feet and in many locations is less than 1,000 feet. The beaches generally rise gradually from the ocean on a slope of about 1 on 30 until they reach sand dunes just above the high tide line. Dune ridges are more or less continuous but irregular and range in height up to about 30 feet. The ocean sides of the dunes have steep slopes carved by the wind while the inshore sides slope gradually and are usually covered with beach grass. From Southampton eastward for a distance of about 20 miles the beaches rise from the ocean on a somewhat steeper slope than that of the barrier beaches and the dunes are not as extensive. Eastward to Montauk Point, the shoreline is characterized by a series of cliffed headlands fronted by a narrow beach with some nearby vertical bluffs rising to a maximum height of nearly 70 feet above the water.

Shore Ownership. Along this reach the only Federally-owned lands bordering the shore are at the Coast Guard Reservation in the Town of Islip; the Fire Island National Seashore in the Towns of Islip and Brookhaven; the Bellport Coast Guard Station in the Town of Brookhaven; the Shinnecock Coast Guard Station in the Town of Southampton; and at U.S. Navy Radio Station; U.S. Army Reservation and Montauk Point Coast Guard Station in the Town of East Hampton.

Of the total shore length of about 108 miles, ownership is about 13 percent or about 14 miles Federal, 33 percent or 36 miles non-Federal public, and 54 percent or 58 miles private. Shore ownership is shown on plates 46, 48, and 50.

Shore Use and Development. In this reach, shore development is primarily residential and recreational in character. Residences along the shore vary from small cottages to large estates, with the latter category being more common at Westhampton Beach and Southampton and the smaller cottages are more common from Fire Island to the west. Some of the shore frontage is undeveloped, particularly along barrier beach east of Fire Island Inlet. The reach is well known for its recreational and seasonal residential development which is found in the form of a National park, State parks, numerous public and private beaches and marina facilities for recreational fleets at several locations. Jones Beach State Park and the Captree State Park are operated by the Long Island State Park Commission. Jones Beach State Park offers for public use the largest single bathing beach in the study area. Gilgo State Park just east of Jones Beach is relatively unimproved for recreational use and will aid in servicing future recreational needs. In 1970, the annual attendance figure for Jones Beach and the Captree State Parks was about 13,900,000 persons. The Fire Island National Seashore will provide additional facilities to help meet the recreational demands of the area. Robert Moses State Park, located on the west end of Fire Island, had a 1970 attendance of about 1,766,900 persons. Hither Hills State Park near East Hampton Beach, offers camping and trailer areas for public use as well as a bathing beach. Montauk Point State Park is principally scenic and none of its frontage is suitable for use as a bathing beach. In 1970, the annual attendance figure for Hither Hills and Montauk Point State Parks, operated by the Long Island State Park Commission, was about 534,300 persons. In addition to annual attendances at the State Parks, beaches and parks operated by local government units had an annual attendance of 2,620,000 persons during 1970. Shore use and development are shown on plates 46, 48, and 50.

Future Development. Recreational development and summer residential development is

expected to continue as is the development of conservation areas due to this area's suitability for recreational and seasonal residential use.

Littoral Drift. The predominant direction of littoral drift is generally from east to west. This is evident by the westward growth of Fire Island over a 115-year period and material impounded by jetties at Rockaway, East Rockaway, Jones, Fire Island, Moriches and Shinnecock Inlets. At Fire Island Inlet, the drift is estimated at 600,000 cubic yards annually. An approximation of the westerly drift at Moriches Inlet is in the order of 300,000 cubic yards annually. At Shinnecock Inlet, it is somewhat less than at Moriches Inlet because of the somewhat greater exposure of the easterly area to the effects of westerly winds and waves which tend to reduce the net littoral drift from the east.

18. SHORES OF GREAT SOUTH BAY AND ADJOINING LESSER BAYS, LONG ISLAND, NEW YORK

Physical Characteristics. This reach, as shown on plates 5, 47, and 49, consists of the shores of those interconnected shallow tidal waterways extending eastward from the Wantagh State Parkway Bridge, South Oyster Bay in the Town of Hempstead to Shinnecock Bay in the Town of Southampton along the south shore of Long Island. It is immediately north of a series of sandy barrier beaches. The shoreline of this reach is about 172 miles in length. There are 39 communities along the shore of the area in six of the seven Towns of Nassau and Suffolk Counties. Jones, Fire Island, Moriches and Shinnecock Inlets, which are 33, 50, 8, and 95 miles, respectively, by water east of the Battery, New York City, connect the Atlantic Ocean with the Inner Bays.

Much of the land along the bays is fringed by marshes and a shallow water shelf having depths less than 3 feet below mean low water. The topography of the mainland is generally gently sloping and is intersected by drowned valleys of numerous streams that drain into the bays. Peninsulas jut out from the mainland in the Smith Point-Mastic Beach and Westhampton Beach-Quogue areas and form a separation between the bays. Narrow Bay, in the Smith Point-Mastic Beach area, is the connecting link between Great South Bay and Moriches Bay and is 4 miles long, 1,000 to 4,000 feet wide with depths up to 10 feet. The Quantuck and Quogue Canals, in the Westhampton Beach-Quogue area, serve as a connecting link between Moriches and Shinnecock Bays and are 4 miles long, generally 100 to 300 feet wide with depths up to 8 feet. The barrier beaches along the southern side of the bays are narrow and low and have irregular sand dunes which range in height up to about 30 feet near the oceanfront.

The portion of the back bay area from East Rockaway Inlet to the Wantagh State Parkway, generally known as Hempstead Bay, is not covered in this report as the greater part of the bay area is sited by a large number of tidal marsh islands and an extensive marsh and wetland area around its periphery. There are no known erosion problems in this area.

Shore Ownership. Along this reach the only Federally-owned lands bordering the shore are at various locations in the portion of reach between Fire Island Inlet and Shinnecock Bay in the Towns of Islip, Brookhaven and Southampton. These include the Fire Island National Seashore and Coast Guard installations.

Of the total shore length of about 172 miles, ownership is 8.6 percent or 14.7 miles Federal, 39.2 percent or 67.4 miles non-Federal pubic, and 52.2 percent or 89.6 miles private. Shore ownership is shown on plates 48 and 50.

Shore Use and Development. In this reach shore development is primarily residential and recreational in character. A number of small manufacturing and commercial establishments are found in the larger communities. The major commercial establishments consist of boat repair and storage yards, lumber and planing mills, printing plants, laundries and dry cleaning establishments. Other establishments are

generally of a supporting nature to the recreational activities of the area. Shellfish and commercial fishing industries are located adjacent to the bays, while large quantities of agricultural products are produced in the tributary areas.

The reach is well known for its recreational and residential development which is found in the form of a National Park, State Parks, numerous public and private beaches and marina facilities for recreational fleets at several locations. Heckscher State Park, operated by the Long Island State Park Commission, is located on the shores of Great South Bay. In 1970, the annual attendance figure at Hechscher Park was 846,100 persons. In addition to Heckscher State Park in the immediate area, Jones Beach State Park included in the South Shore of Long Island, Nassau and Suffolk Counties portion of this study offers for public use the largest single bathing beach adjacent to this reach. The Fire Island National Seashore will provide additional facilities to help meet the recreational demands of the area. In addition to annual attendance at Heckscher State Park, beaches and parks operated by governmental units had an attendance of about 587,000 persons during the 1970 beach season. Shore use and development are shown on plates 48 and 50.

Future Development. The communities bordering the bays are experiencing a very rapid growth in residential construction, which is expected to continue as is the development of recreational, summer residential, and conservation areas due to this area's suitability for recreational and seasonal residential use.

Littoral Drift. The direction of littoral drift along this reach varies depending on the orientation of the shoreline and its exposure to the bay waters.

19. EASTERN FORKS OF LONG ISLAND, SUFFOLK COUNTY, NEW YORK

Physical Characteristics. This reach, shown on plates 5 and 49, consists of the eastern forks of Long Island in Suffolk County, New York, from Orient Point on the north fork to Montauk Point on the south fork. The shoreline of this reach is 168.3 miles in length. There are 28 villages and communities along the shore of this reach in five towns of Suffolk County. Three islands, Shelter Island, Plum Island and Gardiner Island, are included in this reach.

The terrain of the area consists of low bluffs and flats along the southerly shore of the north fork, generally less than 20 feet above mean sea level in elevation, while along the south fork glacial headlands up to 240 feet mean sea level slope, shoreward to meet Peconic and Gardiners Bays. Along the shores of Flanders Bay there are found large extents of tidal marshes.

The bays between the north and south forks form a conspicuous feature of Long Island. Together these bays form a water body increasing in width from a few yards at the mouth of the Peconic River to 14 miles near Gardiners Island, 27 miles farther east. The water body does not increase uniformly in width throughout and is much broken by islands, the largest of which is Shelter Island and by projecting necks mostly connected with the mainland by beaches, among which are Jessup and Hog Necks, near Sag Harbor, on the south side, and Little and Great Hog Necks, in Southold, on the north side. These islands and necks all stand from 50 to 100 feet or more above mean sea level.

Shore Ownership. In this reach the only Federally-owned lands bordering the shore are at Jessup Neck where there is a National Wildlife Refuge. The Federally-owned shore comprises about 4.1 miles or 2.4 percent of the total shore in the reach.

Gardiners Island which is the second largest in the area with 15.1 miles of shoreline, is entirely privately owned. Plum Island with 7.1 miles of shoreline is publicly owned and is the site of a Federal agricultural research station. Non-Federally publicly owned shores amount to about 40.6 miles or 24 percent of the total

shore in this reach, while privately-owned shore accounts for the remaining 123.6 miles of shore or 73.6 percent of the total shore. Shore ownership is shown on plate 50.

Shore Use and Development. In this reach shore development is primarily residential and recreational in character. Residences along the shore vary in size from large estates to small cottages. Much of this type of development is found along the numerous necks and beaches in the area. There are three State parks in the area at Orient Point, Hither Hills, and Montauk Point, where bathing and other recreation activities can be enjoyed. In 1970, the annual attendance at Orient Beach State Park was 111,300 persons and 534,300 persons at Hither Hills and Montauk Point State Parks. In addition to annual attendances at the State Parks, beaches and parks operated by local governmental units had an annual attendance of about 75,000 persons during 1970. On Jessup Neck the Morton National Wildlife Refuge is located. There is a county park at Cedar Point. There are numerous boat harbors and marinas in the area.

Boat ferries operate from Shelter Island to Greenport on the north and to Sag Harbor on the south. The Shinnecock Canal connects Great Peconic Bay with Shinnecock Bay. Shore use and development are shown on plate 50.

Future Development. Residential development is expected to continue but will probably be limited by zoning. Development of parks and conservation area is also expected to continue.

Littoral Drift. Due to the shore configuaration such as the numerous necks and to the limited fetches within this reach, there is no one predominant direction of littoral drift. Such directions of drift will oftentimes be split along the projecting headlands and necks.

20. NORTH SHORE OF LONG ISLAND, SUFFOLK COUNTY, NEW YORK

Physical Characteristics. This reach, shown on plates 5, 47, and 49, consists of that portion of the north shore of Long Island in Suffolk County, New York, extending from Cold Spring Harbor in the Town of Huntington to Orient Point in the Town of Southold. The shoreline of this reach is about 87 miles in length and comprises about 75 percent of the total frontage of the north shore of the island along Long Island Sound. The westerly limit of the study area is about 40 miles by highway from New York City. There are 45 villages along the shore of the area in five towns of Suffolk County.

The terrain of the area consists of rolling hills and flats rising to elevations of up to 200 feet above mean sea level and terminating at the shore with high bluffs, fronted by narrow beaches. West of Port Jefferson, the shoreline is highly irregular, being indented by many bays. East of Port Jefferson, the shoreline is very regular, being made up of long gently curved reaches. In these reaches, the elevation of the bluffs above mean sea level becomes less, decreasing from 150 feet near Port Jefferson to 100 feet north of Riverhead, and to less than 50 feet near Orient Point.

Shore Ownership. Along this reach the only Federally-owned lands bordering the shore are at the Eaton Neck Coast Guard Station in the Town of Huntington, at Old Field Point in the Town of Brookhaven and at Horton Point in the Town of Southold. A navigation beacon is in operation at each location. The Federal lands comprise about 0.2 percent of the total length of shore of the reach.

Of the total shore length of 87 miles, ownership is about 0.2 percent or 0.2 mile Federal, 18.4 percent or 16.0 miles non-Federal public, and 81.4 percent or 70.8 miles private. Shore ownership is shown on plates 48 and 50.

Shore Use and Development. In this reach shore development is primarily residential and recreational in character with some commerce and industry. Residences along the shore vary in size from large estates to small cottages, with the latter category being found in preponder-

ance. With the exception of the concentrated low-lying development around harbor areas, residences bordering the shore are found primarily on the top of high bluffs and secondarily on the backshores of beaches and barrier bars. Commercial and industrial development is found generally in the vicinity of harbor areas or seats of local governments. The reach is well known for its recreational development which is found in the form of State parks, numerous public and private beaches and marina facilities for recreational fleets at several locations. Sunken Meadow State Park, operated by the Long Island State Park Commission, offers for public use the largest single bathing beach in the area, and in 1970 had a total annual attendance of 1,766,700 people. Wildwood State Park near Wading River, offers camping and trailer areas for public use as well as an excellent beach. The 1970 attendance figure of Wildwood State Park was 434,200 persons. In addition to annual attendance at State Parks, beaches and parks operated by local governmental units had an annual attendance of about 70,000 persons during 1970. Caumsett State Park on Lloyd Neck, as yet undeveloped, will aid in serving future recreational needs. An example of the demand for recreational facilities is shown by the recent construction of marinas at Mount Sinai Harbor by a group of private citizens. Shore use and development are shown on plates 48 and 50.

Future Development. Summer residential development is expected to continue as is development of parks and conservation areas.

Littoral Drift. The predominant direction of littoral drift is generally from west to east, except at projecting headlands where the direction of littoral drift is often split along two directions. Generally littoral currents do not carry sufficient material to nourish adequately the down-drift shores. However, along some shores such as at Friars Head in Riverhead, construction of long groins have impounded short beaches of appreciable width.

21. NORTH SHORE OF LONG ISLAND, NASSAU COUNTY, NEW YORK

Physical Characteristics. This reach, shown on plates 5 and 45, consists of that portion of the north shore of Long Island to Nassau County, New York, extending from Little Neck Bay in the Town of North Hempstead to Cold Spring Harbor in the Town of Oyster Bay. The shoreline of this reach is about 16 miles in length and comprises about 16 percent of the total frontage of the north shore of Long Island along Long Island Sound.

The terrain of this reach consists generally of relatively high bluffs with elevations rising to about 180 feet above mean sea level and is very irregular, being broken by numerous bays, coves and inlets. East of Bayville the shoreline is low-lying and characterized by sandy beaches backed by marshes.

This reach is well known for its recreational development which is generally found in the form of numerous private and public beaches and marina facilities for recreational fleets at several locations.

Shore Ownership. Of the total length of shore of 16.0 miles, about 3.6 miles or 22.5 percent is non-Federal publicly owned and 12.4 miles or 77.5 percent is privately owned. Shore ownership is shown on plate 46.

Shore Use and Development. In this reach, shore development is primarily residential and recreational in character with some commerce and industry. Residences along the shore vary in size from large estates to small cottages. With the exception of the concentrated low-lying development around harbor areas, the residences bordering the shore are found primarily on high ground. Commercial and industrial development is found generally in the vicinity of harbor areas or seats of local governments. In 1970, beaches operated by local governmental units had an annual attendance of about 600,000 persons. Shore use and development are shown on plate 46.

Future Development. Future development in this area is expected to be very limited as most of the available lands have been or are presently undergoing development.

Littoral Drift. Due to the configuration and characteristics of the shore there is one predominant direction of littoral drift. Oftentimes the directions of littoral drift will be split by projecting headlands.

22. SHORE OF NEW YORK CITY ALONG LONG ISLAND SOUND WESTCHESTER COUNTY TO THROGS NECK

Physical Characteristics. This reach, as shown on plates 5 and 51, consists of that portion of the New York City shore in the Borough of the Bronx, including City and Hart Islands fronting the Long Island Sound and extending from the northern boundary of New York City at Pelham Bay Park to Throgs Neck at the western limit of Long Island Sound. The shore of this reach is about 17.8 miles in length.

The terrain of this reach is quite rugged. The shoreline in this area is generally steep and narrow, and is composed of cobbles and gravel, with frequent rock outcrops. The shoreline is broken by a bay and other indentations of varying sizes. Natural sandy beaches of very limited sizes are found only in coves and on the leeward sides of projecting points and islands.

Shore ownership. There is no Federally-owned land bordering the shore in this reach. Pelham Bay Park and Orchard Beach operated by the City of New York offers for public use one of the largest bathing and park facilities in the area. The attendance during the 1970 beach season at Orchard Beach was about 3,017,400 persons.

Of the total shore length of about 17.8 miles including City and Hart Island, about 59.6 percent or about 10.6 miles is non-Federal publicly-owned and about 40.4 percent or about 7.2 miles is privately-owned.

Shore ownership is shown on plate 46.

Shore Use and Development. In this reach shore development is primarily residential and recreational in character with some commerce and industry with the exception of Hart Island, the location of Potters Field, which is used by the City of New York as a burial ground for the City's unclaimed dead. City Island is the location of a highly developed boating center where numerous commercial and recreational craft berth particularly along its western shore. Shore use and development are shown on plate 46.

Future Development. Residential and recreational development are expected to continue.

Littoral Drift. Information on the predominent direction of littoral drift along this reach is not available. The quantity of drift is believed to be small.

23. WESTCHESTER COUNTY, NEW YORK, ALONG LONG ISLAND SOUND

Physical Characteristics. This reach, as shown on plates 5 and 51, consists of the eastern shores of Weschester County, New York along Long Island Sound. New York City is west of the area and Greenwich, Connecticut, is to the east. Various small islands lie south of the mainland. The shoreline of this reach is about 40 miles in length entirely in Westchester County. The westerly limit of this reach is about 16 miles by highway from New York City. There are six communities along the shore of this reach in two towns of Westchester County.

The terrain of the study area consists of rolling hills which rise gently from sea level in a northerly direction.

Shore Ownership. Of the total shore length of about 41.7 miles including the 2-mile shore of Glen Island, ownership is about 22.3 percent or 9.3 miles non-Federal public, and 77.7 percent or 32.4 miles private. Shore ownership is shown on plate 52.

Shore Use and Development. Shore development is primarily high income residential in character with grounds generally developed and maintained to the water's edge. In addition to a few public and private beaches, bath and summer houses are located on some waterfront areas with piers and boathouses extending into the water. Residences are primarily on high ground. Recreational development is found in the form of county parks, numerous public and private beaches and marina facilities at several locations. Glen Island Park operated by Westchester County and a large amusement center in the City of Rye known as Playland offers for public use the largest bathing beaches in the area. Glen Island Park had a 1970 attendance of about 135,000 persons. Shore use and development are shown on plate 52.

Future Development. It can be expected that residential and recreational development will continue.

Littoral Drift. Because of the rocky nature of much of the shore, there is relatively little material in littoral movement.

24. CONNECTICUT (FAIRFIELD, NEW HAVEN, NEW LONDON & MIDDLESEX COUNTIES)

Physical Characteristics. The Connecticut shoreline lies along the north shore of Long Island Sound and extends for a distance of about 110 miles by highway from the mouth of the Byram River at the New York state line easterly to the Pawcatuck River at the Rhode Island state line. The actual length of shoreline under study is about 270 miles when allowing for the irregularity of the coastline, which involves embayments and the outer tidal estuaries. This includes the offshore Fisher's Island, New York, which is in the proximity of the Connecticut shore. Among the principal indentations in the shoreline are the harbors at Greenwich, Stamford, Norwalk, Bridgeport, and New Haven and the outer estuaries of the State's major rivers, the Housatonic, Connecticut, and Thames.

The shorefront can be generalized into two geographical categories—the reach between the New York state line and Norwalk Harbor and that between Norwalk Harbor and the Rhode Island state line. The former sector consists of many rock outcrops, is irregular and generally lacking in depositional and erosional features. Most of the beaches that exist in the area are small sandy pocket beaches contained between rocky headlands. The remaining sector east of Norwalk Harbor consists largely of sandy barrier beaches fronting low marsh areas. There are a few headlands within this area composed of glacial unconsolidated till, with scattered locations of rocky headlands existing within some bays and numerous outcrops of bedrock characterizing the shore.

It is estimated that of the 270 miles of the Connecticut shorefront, 145 miles normally contain a beach. Generally, beaches along the whole shoreline are relatively narrow with normal tides approaching the backshore making them inadequate as protective features or for recreational use. Many beaches have sectors containing gravelly and coarse sand deposits. Cobbles are prevalent along sectors of the more exposed beaches. Some of these beaches have limited areas of sand with a texture suitable for recreational use. There are several beaches east of Norwalk Harbor of the barrier type that are generally composed of medium texture sand which is very satisfactory for recreational saltwater bathing use.

There are a variety of protective structures along the shorefront. Stone and timber constructed groins are common along many beach areas. Bulkhead construction fronts the shorefront bordering inner harbors along the city commercial and industrial developments. In some instances, bulkhead or revetment extends along exposed backshore areas protecting private property. The more massive construction is confined to some jetty or breakeater structures constructed by the State and Federal government.

Fisher's Island, located several miles off New London, is a small narrow island 7 miles in length oriented in a northeasterly direction containing 20 miles of shorefront. The island consists of a variety of geological features including high bluffs rising in excess of 50 feet above mean low water, salt ponds and marshes fronted by sandy barrier beaches. Most of the beach and marsh areas are located along the southerly sector bordering Block Island Sound, with deeper embayments and harbors, along the north shore fronting Fisher's Island. This entire reach is shown on plates 6 and 53.

Shore Ownership. About 50 miles of the 270 miles of shorefront are publicly-owned, 5 miles are Federal owned and the remainder is privately owned (see plate no. 54 which displays shore ownership types and use). The publicly-owned property includes four state parks and associated beaches—Sherwood Island State Park in Westport, Hammonasset State Park in Madison, Rocky Neck State Park in East Lyne and Harkness Memorial Park in Waterford. The other publicly-owned property consists of numerous scattered town and city-owned beaches. The Federal property consists of the Coast Guard Training Station in Groton and Coast Guard property on Fisher's Island. Private property is generally summer and permanent residential with commercial industrial located within the urban city areas. On Fisher's Island there are numerous estates located on the eastern end with permanent and summer residential property scattered throughout the remainder of the island. Shore ownership is shown on plate 54.

Shore Use and Development. The use of the shorefront is primarily summer, permanent residential and public recreational consisting of numerous parks and publicly-owned beaches. These public recreational use beach areas located along the coastline attract numerous visitors from all of the surrounding areas. Up to 10,000,000 annual visitations have been recorded for 18 cooperative beach projects within this area. Residential development consists generally of private associations frequently fronted by beaches. There are also privately-owned residences with shorefront property along the coast. Residents both permanent and seasonal, enjoy the life associated with scenic coastal living including salt water bathing and boating, throughout the recreational season. Quiet residential living is enjoyed by a substantial number of permanent residents. The population increases during the summer months by the return of summer residents and visitation of thousands of tourists enjoying the public beaches. Of the 270 miles of shorefront, it is estimated that 30 miles are in public recreational use and 225 miles for private recreation, with the remainder being used commercially or industrially. Shore use and development are shown on plate 54.

Future Development. The Connecticut coastal area is within convenient day-trip distance of the heavily populated area of the New York City Megalopolis and other large cities in southern New England. It is easily reached by public and private transportation on major coastal and branching highways as well as by air travel. With the increasing demands of a vacationing and tourist populace for recreational saltwater bathing, it is likely that expansion of both public and private use beaches will be accomplished. Construction of shorefront residential property, both permanent and seasonal, will also continue to grow.

Littoral Drift. The littoral drift, generally, is eastward along shores running east and west and northward along shores running north and south. The irregularities in the shoreline and the presence of numerous islands present obstructions and result in the movement of littoral drift in directions different from the general predominant direction at localized areas. The development of the shoreline has resulted in stabliizing sand beaches and in holding back potentially erodible sand materials at sand bluffs. Consequently, the rate and volume of littoral drift materials has decreased in recent years.

25. RHODE ISLAND INCLUDING BLOCK ISLAND (COUNTIES OF KINGSTON, WASHINGTON, KENT, AND NEWPORT)

Physical Characteristics. Rhode Island has a shoreline estimated at 340 miles in length including Block Island and Narragansett Bay as shown on plates 6 and 55. Of this, 190 miles are along the exposed southerly sector extending along Block Island Sound, including the outer extremities of Narragansett Bay and Block Island. The inner portion of the Narragansett Bay is about 150 miles in length with about 30 percent sandy beaches. The south shore of Rhode Island bordering Block Island Sound from the Connecticut State line to the west passage of Narragansett Bay constitutes the major sector. Narragansett Bay separates this south shore sector from a short reach of the remaining portion of the entire Rhode Island south shore described as the east shore, bordering Rhode Island Sound on the southeast extremity of Narragansett Bay. The Sakonnet River further divides the southern portion of the eastern sector nearly in half. The island of Jamestown divides the lower Narragansett Bay into an east and west passage. Of the 190 miles of exposed shorefront, it is estimated that 140 miles normally contain beaches.

The shorefront between the Connecticut-Rhode Island line and Narragansett Bay is primarily one of long barrier beaches extending between headlands of unconsolidated materials fronting a series of salt ponds. Much of the backshore contains low dunes that furnish substantial protection to inland areas. The outer exposed area of lower Narragansett Bay contains small pocket or crescent-shaped beaches located between massive ledge outcroppings. The eastern shore of Rhode Island is similarly constructed, geologically. The east shore includes the nationally known Cliff Walk that is fronted partially by soft erodible rock in direct contrast to the massive granite outcropping found within much of the outer exposed Narragansett Bay area. The inner area of the Narragansett Bay area northward to Providence is less severely exposed than the south shore, with natural and manmade structures properly maintained, generally affording satisfactory erosion control protection except during rare instances of hurricanes.

In general, all of the beach areas consist of unconsolidated glacial materials susceptible to rapid movement by storm-driven wave action, and most of the beach berms are quite narrow, inadequate as a protective and recreational use measure. Although most of the beaches contain sand of fine to medium texture, making them suitable for recreational purposes, there are sectors that are gravelly and in some instances scattered with rocks and boulders. In general, protective structures along the south shore consist of a few low seawalls, bulkheads or groins fronting private property. Massive construction is lacking along the south shore except for the large State and Federal breakwaters at Point Judith. There are, however, extensive massive stone and concrete seawalls fronting private property within the Cliff Walk area of Newport.

Block Island, located about 12 miles south of the Rhode Island coast, has a land area of approximately 11 square miles and a shoreline length of 16 miles. The north shore, bordering Block Island Sound, consists of low barrier beaches extending between headlands. The south shore, fronting the Atlantic Ocean, consists of high steep erodible bluffs of glacial till. The eastern shore facing Rhode Island Sound consists of bluffs, sand dunes and low stretches of barrier beaches. The west shore faces Block Island Sound and consists of sand beaches fronting eroding sand dunes that are scattered along the backshore. Patches of gravel or cobbles appear frequently along the northern portion of the shore. The southern half of this shore consists of barrier beaches fronting Great Salt Pond. There are few protective structures within the area other than low bulkheads fronting the commercial development at the Harbor of Refuge located at the eastern side of

the island. Here, and at the west navigation entrance to the Great Salt Pond, are located the only massive manmade structures on the island—State and Federal jetties.

Shore Ownership. The outer 190 miles of Rhode Island shore includes 145 miles of private property, 40 miles of public property and 5 miles of Federal property. The public lands are equally State and town beaches. Most of the public shores extend west of Narragansett Bay, the more prominent beaches being Napatree, Misquamicut, Sand Hill Cove, and Scarborough Beaches. Other public beaches of varying size are situated between stretches of private shores of the remainder of the State's shoreline. Federal property consists of U.S. Coast Guard Stations, U.S. Navy, or other military installations located at or within the vicinity of the outer extremity of Narragansett Bay. The 150 miles of inner shorefront of Narragansett Bay is estimated to be in excess of 90 percent private ownership. Block Island is nearly all privately owned. Shore ownership is shown on plate 56.

Shore Use and Development. All but 5 miles of the outer exposed area of the Rhode Island shorefront, including Block Island, is used for recreational purposes, either public or private. The five miles are Federal property. Private property fronting an estimated 145 miles of shore, including Block Island, consists of small and larger summer cottages along most of the shore. The occupants use the fine sandy beaches for recreational bathing. Much of the Newport shorefront is occupied by large estates. The remaining 40 miles of shore consists of public beaches enjoyed not only by the residents of Rhode Island, but by great numbers of summer vacationists and tourists from out of state. Actual visitation figures for all of the beach areas are unavailable, however, it has been reported that at the two cooperative State and Federal beaches, Sand Hill Cove and Misquamicut, that over 1,000,000 people visit them annually. The inner Narragansett Bay area is estimated to be at least 90 percent used for recreation with private recreation predominating. Other uses within the urbanized areas are commercial and industrial. Shore use and development are shown on plate 56.

Future Development. The backshore west of Point Judith has been highly developed for summer cottages and has the capability to continue to grow. The public beaches of this area have been able to meet the demands of the public adequately. However, the present trend toward increasing recreational use demands and future recreational requirements of the public will require more and larger beaches. Newport is not expected to develop as rapidly because it has been more fully developed as a large estate and residential area. However, the shoreline east of Newport has the potential to be developed as a permanent residential and summer resort area. Such development is expected to expand with the public demand for summer cottages continuing to increase.

Littoral Drift. There has been only one study made within the more erodible areas of Rhode Island that has discussed littoral movement of material in some detail. This has been the study made for the south shore of Rhode Island. Generally, for beaches having a north to south orientation, the drift is predominantly to the north as would be expected based on the direction of storm-driven waves. For beaches oriented in an east-west direction the predominant drift appears to be toward the west. Small pocket-type beaches located within rocky projecting headlands generally indicate no predominant direction of drift. No detailed studies have been made for Block Island, but based on engineering judgment and field observations it is believed that the same beach orientation drift direction relationship as discusses for the mainland would generally apply.

26. MASSACHUSETTS ELIZABETH ISLANDS, MARTHA'S VINEYARD, NANTUCKET (DUKES COUNTY)

Physical Characteristics. The islands in this

reach, as shown on plates 6 and 57, were geologically formed from glacial materials of two belts of terminal moraines resulting apparently when the continental ice sheet made two halts in the region. The earlier moraine formation known as the Ronkonkoma formation resulted in Martha's Vineyard and Nantucket Islands. A later moraine formation known as the Harbor Hill moraine resulted in the Cape Elizabeth Islands. About 230 miles of the 300-mile shorefront consists of sandy beaches. The physical characteristics of the islands are discussed individually in the following paragraphs.

The Elizabeth Islands, consisting of a narrow island chain, begin about one-half mile offshore of the southwestern extremity of Cape Cod near Nobska Point and extend in a southwest direction for about 11 miles. They border Buzzards Bay to the northwest and Vineyard Sound to the southeast. The islands rise as high as 150 feet above mean low water with steep sandy bluffs generally rising quite steeply along the southeastern exposure. The northwestern shorefront, although as a whole rising well above sea level, does not sustain the steepness experienced along the southeastern exposure. There are generally no protective improvements for the islands except within the Cuttyhunk Island area that contains the major development on the islands.

Martha's Vineyard is located about 3 miles offshore of the southwestern shore of Cape Cod. The island is oriented along an east-west direction and is 18 miles long by 3 miles wide. Chappaquiddick Island, although geologically speaking a part of Martha's Vineyard, borders the southeastern portion of the island separated by an embayment on the island known as Katama Bay. Martha's Vineyard is bordered on the north by Vineyard Sound, on the east by Nantucket Sound, on the south by the Atlantic Ocean and the west by Rhode Island Sound. The shorefront is generally backed by low dunes except at the northwestern extremity where the Gay Head Cliffs are located. These cliffs are unique in structure consisting of multi-colored clays and sands rising steeply up to about 140 feet above mean low water. The south shore of the islands contains a series of scallop-shaped saltwater ponds fronted by barrier beaches. The beaches are generally narrow consisting of well-graded beach fill of medium texture with steep beach slopes averaging about 10 horizontal on 1 vertical. The eastern exposure contains good recreational beaches most of which are quite wide and suitable for present day recreational use. Protective structures are generally confined to developed areas consisting of some scattered stone or timber or groin structures, concrete seawalls, timber or bulkheads. Along some high embankments exposed to the easterly storms there are some massive stone revetment structures built by State and local interests.

Nantucket Island is located about 20 miles south of Cape Cod. It is about 12 miles in length and averages about 3 miles in width. The island is bordered on the north by Nantucket Sound and on the south by the Atlantic Ocean. As a whole, the entire shorefront has a backshore consisting of low dunes fronted by a beach berm of substantial width. A portion of the eastern exposure, however, contains steep bluffs rising up to about 50 feet above mean water levels. Portions of the southeastern and estern exposure are fronted by a wide vegetated beach berm which is in turn fronted by a wide beach. The southern and eastern beach slopes are steep averaging about 10 horizontal on 1 vertical. The northern, lesser exposed shorefront contains flatter beaches, fronting low dunes, or barrier type beaches fronting the natural harbor embayment. A few rapidly eroding barrier beaches front salt ponds along the southeast shore. There are a few erosion control improvements along the island. Major improvements are bulkheads, revetment and stone jetty construction fronting the Nantucket Harbor areas.

Shore Ownership. The Elizabeth Island chain is largely undeveloped. Cuttyhunk Island has a

sheltered settlement at the southwesterly sector of shorefront bordering Cuttyhunk Pond consisting of summer residential property with a few permanent residents. With the exception of U.S. Coast Guard property at the entrance to Cuttyhunk Harbor, shorefront property is generally privately owned, summer residential and with a few permanent residents.

Martha's Vineyard—Although the most heavily populated of the offshore islands, has extensive reaches of undeveloped, privately-owned shorefront property. The developed coastal areas are generally confined to the northeast and easterly shorefront and consist of larger village areas located between West Chop and Edgartown, intermingled with scattered residential properties. Much of the south shore is undeveloped. There are a few scattered cottages or homes located well inland of the barrier beaches along the salt ponds or at bluff areas. The northern shorefront is generally undeveloped except for a few scattered properties.

Nantucket Island—This island has three principal areas of concentrated coastal development—Nantucket proper, centrally located at Nantucket Harbor on the north shore; Siasconset, mainly a summer residential settlement located inland of high bluffs along the southeastern sector; and the small residential development of Madaket located at the southwestern sector of the island bordering Madaket Harbor. There are a few summer residential properties scattered along the shorefront of the island and adjoining Smith Point and Tuckernuck Island. Much of the shorefront is undeveloped but privately owned.

On all these island groups, there is very little publicly owned property. It is estimated that of the total combined length of shorefront of 300 miles, only 50 miles are publicly owned, 5 miles are Federal property and the remainder is in private ownership. See plate 58 which displays types of shore ownership.

Shore Use and Development. The shorefront use of all these islands is primarily summer recreation with all beach areas, private or public, extensively used for saltwater bathing. The Gay Head Cliffs, nationally known for their exceptional beauty vividly displayed as a painted texture of sands and clays rising high above the sea at the westerly extremity of Martha's Vineyard, attract large numbers of tourists each year. Summer residents and vacationists return frequently to enjoy hiking and to explore along the shorefront at the base of the cliffs for ancient relics exposed at times, remnants of changes dating through 14,000,000 years of geologic history.

Several municipalities have historic significance, featuring very old homes and cobblestone streets dating back to the time of the sailing ships and the commercial whaling industry. In Nantucket, a whaling museum attracts many visitors each season. Of the total shoreline of 300 miles, it is estimated that about 50 miles are open to public use, 170 miles are used for private recreation purposes, 70 miles, mainly along the Elizabeth Island group and south shore of Martha's Vineyard are undeveloped and 10 miles consisting of commercial docks and wharves areas are non-recreational. See plate No. 58 which portrays shore use and development.

Future Development. The islands are conveniently accessible to the mainland by boat and air transportation, both commercial and private. They are becoming increasingly popular to a rapidly growing summer tourist and vacation populace. The islands all have extensive undeveloped shorefront property. It is reasonable to forecast that this property will be developed appropriately for both public and private use. This would include summer residential homes, public parks and extending private and public use beach areas.

Littoral Drift. This is discussed broadly with information limited to only partial coverage of the area based on brief field investigations and application of engineering judgment. A beach erosion control study covering the easterly exposure of Martha's Vineyard contained

between East Chop and Edgartown Harbor discussed this to some degree. This study indicated a predominant southerly drift for the eastern sector. Field observations along the south shore indicate that the predominant direction of drift is generally to the east. For Nantucket Island, the ebb and flood currents to Nantucket Sound and the effect of offshore shoals complicate the littoral processes along the island. A predominant westerly drift is indicated at the southwesterly portion of the island by extensive trailing spits. The northerly portion of the island indicates a northerly movement by the trailing submerged shoal extending in the direction of Monomoy Island. In general, there is a predominant southerly drift indicated on the east shore and a predominant westerly drift along the southeast exposure. There appears to be a nodal point at the central sector of the south shore where there is a predominant easterly drift of material meeting the westerly movement of material from the southeast corner. This is apparently localized.

27. RHODE ISLAND STATE LINE TO PROVINCETOWN (BRISTOL, PLYMOUTH, AND BARNSTABLE COUNTIES)

Physical Characteristics. The area from the Rhode Island state line to Buzzards Bay consists of extensive barrier beaches fronting marshes and ponds. The beaches are generally backed by dune formations. The Buzzards Bay area, typical of a shore of youthful submergence, contains numerous low sandy flat projections intermingled with some low rocky headlands. Sandy spits or other shaped sand bars are scattered throughout the bay. The outer exposed shoreline of the bay is considered in the study. The southern Cape Cod shorefront is the glacial outwash plain fronting the Harbor Hill moraine, formed during the latest advance of the glaciar, the moraine forming the Elizabethan chain of islands, extending as the northern ridge or upper arm of Cape Cod and disappearing seaward at the easterly end of the Cape at the bend of the outer arm.

The southwestern quarter of the Cape Cod shorefront in the towns of Falmouth and Mashpee takes on a scalloped appearance as shaped by the deeply indented salt ponds fronted by barrier beaches or spits. The remainder of the south shore of the Cape is characterized by the numerous bay and extensive beach formations, crescent shaped or long barrier bars or spits contained between Great Neck and Point Gammon, then becoming rather uniformly straight with sandy beaches fronting dunes and some marsh areas to its termination at the southern entrance to Chatham Harbor.

The outer arm of the Cape and Monomoy Island varies in structure from the low north-south oriented barrier reef of Monomoy Island and the low southern portion of the arm forming Nauset Beach, to the high steep bluffs fronted by a continuous sandy beach extending northerly of Nauset Bay. The northerly half of Nauset Beach contains dune formations along the backshore with intermediate low areas throughout.

Most of the beach berms throughout the entire reach are inadequate for protective and recreational beach use except at the updrift side of some jetty or groin structures. In general, the beach sand is of good texture for bathing use. However, at some sections such as Long Beach at Craigville, it is reported that a substantial section of shorefront has deteriorated over the years to a rather gravelly texture within the surf zone. The beach slopes are comparatively flat except along sections of the easterly exposure of the outer arm where frequent easterly storms steepen the slopes within the surf zone.

There are a variety of protective structures, mostly contained along the exposed heavily developed south shore of Cape Cod. The predominant type of structures are timber or stone groin structures. There are a few instances where embankments are protected by bulkheads or massive rock revetment. Massive

construction consists primarily of stone jetty structures at the entrance to boat harbors constructed by the State and local interests or in cooperation with the Federal government. The outer arm of Cape Cod generally contains no protective structures. It is estimated that of the 440 miles in this reach of shorefront, 370 miles normally contain beaches. Beach areas are shown on plates 59 and 61.

Shore Ownership. Of the 440 miles of shorefront about 50 miles are publicly owned, 50 miles are Federal property with the remainder in private ownership. The public property is primarily owned by the municipalities in the form of recreational beaches or property fronting town street ends. The Commonwealth of Massachusetts owns three State parks—Horseneck State Reservation, Demarest Lloyd State Park, and Fort Phoenix State Reservation. The Federal ownership consists of the Monomoy Federal Wildlife Reserve and the Cape Cod National Seashore. The proposed ownership of the latter includes the entire easterly shorefront of the outer arm of Cape Cod of which about one-half of the northern portion has been acquired with only certain sections presently open to the general public. Shore ownership is shown on plates 60 and 62.

Shore Use and Development. The use of the shorefront, with the exception of the city or town development areas, is primarily recreation. The Buzzards Bay area contains the City of New Bedford, the Towns of Fairhaven, Wareham, and Marion, all having a variety of shorefront structures such as wharves, docks, and warehouses. Within the embayment there are also numerous small beach areas and permanent and summer shorefront housing developments within the bay. The shorefront between Rhode Island and Buzzards Bay is largely devoted to recreational use with the State reservation at Horseneck Beach and Demarest Lloyd State Park and Fort Phoenix State Beach being popular during the summer recreational season.

The south shore of Cape Cod east of Buzzards Bay is nearly a continuous system of recreational beaches either public or private fronting heavy concentrations of developed areas. Most of the shorefront property is summer residential in great seasonal demand by a vacationing populace. The Monomoy Island and outer Cape Cod areas are either sparsely populated or unpopulated and receive numerous visitors to the National Seashore and Wilderness sites contained therein. These sites provide for saltwater bathing, quiet solitude, picturesque dunes, and scenic high sandy bluffs overlooking the ocean. Of the 440 miles of shorefront, it is estimated that 90 miles are in public recreational use, 335 miles are used for private recreation and 15 miles for non-recreational use. Shore use and development are shown on plates 60 and 62.

Future Development. In this area of great demand for recreational shorefront living and saltwater bathing activities, it is reasonable to forecast a continued increase in permanent and summer residential development. It is also likely that public use beach areas will be expanded to furnish needed beach use area. The National Seashore should continue to develop with much of the outher Cape Cod area open to general public use.

Litorral Drift. The southern shorefront of Massachusetts is generally exposed to southerly storms and less frequently to hurricanes. The direction of littoral drift within the Buzzards Bay area is dictated by the shorefront configuration and exposure. Although there are no detailed studies to authenticate littoral transport either quantitatively or as to direction, it is likely that shorefronts with a north to south orientation will have an appreciable northerly transport while east to west shorelines will have a predominant easterly transport. For the southerly exposure from Buzzards Bay to Chatham, there are indications along much of the shorefront that littoral transport is to the east as shown by the accretion on the west side of groin and jetty structures. There are some areas, however, where there is no predominant

direction of littoral drift particularly within the more indented areas less subject to the larger storm-driven waves. There are limited strectches of the southern shorefront where a predominant westerly drift is in evidence. The outer arm of Cape Cod and the easterly exposure of Monomoy Island, experience a predominant southerly drift due to the greater frequency of northeasterly and easterly storms. The portion extending northerly from about southern Truro to Provincetown experiences a northerly drift.

28. PROVINCETOWN TO PEMBERTON POINT, MASSACHUSETTS (BARNSTABLE AND PLYMOUTH COUNTIES)

Physical Characteristics. The geological structure between Provincetown and Pemberton Point is consistent with formations created through glacial and fluvio-glacial deposition modified by wave action along an initial shoreline of submergence. The sector between Provincetown and the Cape Cod Canal is within or near the Harbor Hill moraine formation, the latest advance of the continental ice sheet. The sector of shorefront north of the Cape Cod Canal is marked by drumlin formations at some locations such as are found in the Nantasket and Duxbury-Scituate area. The shorefront from Provincetown to the vicinity of North Scituate consists of sandy beaches of varying widths, slopes and texture fronting bluffs or dunes. The bluffs extend for some distances along the westerly backshore of the outer arm of Cape Cod intermingled with dune formations but with dunes becoming the most predominant backshore feature along Cape Cod's north shore to just north of the Cape Cod Canal. The bluffs again are featured along the backshore with intermingling sectors of dune formations to within the Marshfield-Scituate area. Here the higher formations rising in excess of 100 feet above mean low water are so pronounced a backshore feature as to be named First, Second, Third, and Fourth Cliffs. North of Scituate the area is made up of pocket beaches located between ledge outcrop headlands, except for the extensive tombolo structure of Nantasket Beach which is located just west of Pemberton Point. In general, from Provincetown through the Duxbury area, the beaches extend as long straight stretches of protective beach berms with stone areas containing shaped sandy spits. Such prominant beach shapes as the Duxbury Beach tombolo and Long Beach at Plymouth, a bay mouth bar, are found within this area. It is estimated that of the 200 miles of shorefront in this reach, 165 miles normally contain beaches. Beach areas are shown on plates 59, 61, 63, and 65.

Backshore protection along the northern half of the shorefront is predominantly of the massive concrete seawall and stone revetment type fronting coastal roads, bluffs or housing developments, whereas protection along much of the shorefront along the southern half is of the beach protection variety consisting of numerous stone or timber groins. Much of the construction was completed cooperatively by the towns and state, although there are a few instances where private property owners have constructed less expensive structures such as light timber bulkheading or small groin structures. This reach is shown on plate 6.

Shore Ownership. Of the 200 miles of shorefront, it is estimated that 155 miles are privately owned, 30 miles are publicly owned with 15 miles Federally owned. There is comparatively limited shorefront available for public use. Most of the private property is summer residendial. The majority of the publicly owned shorefront with substantial sandy beach area is located along the southern half of the reach. There are, however, approximately 7 miles of public beach area north of the Cape Cod Canal. One of the more popular public beaches north of the Canal is Nantasket Beach owned and operated by the Metropolitan District Commission, Commonwealth of Massachusetts, and located just east of Pemberton Point. Other State-administered beaches are Scusset State Beach adjacent to and im-

mediately north of the Cape Cod Canal (Federal property leased to the State) and Provincetown State Beach located at the eastermost end of the reach. Federal ownership consists of property owned by the U.S. Air Force at Fourth Cliff, property adjacent to the jetty structures at the Cape Cod Canal and National Sea Shore property on Cape Cod Bay. See plate nos. 60, 62, 64, and 66 which display types of shore ownership and use.

Shore Use and Development. The present shore use is nearly entirely of the summer residential or summer recreational beach use variety. The residential development either consists of numerous closely spaced summer cottages at attractive residential bathing beach areas or in some cases scattered individual properties usually located along higher or bluff areas. In some instances, particularly within the northern section closer to the Boston megalopolis, there are some permanent residential homes. All public beach areas are presently used to their capacity during the saltwater bathing season. Actual visitation figures are limited in this area, however, it has been reported that 200,000 bathers visit the cooperative projects at Plymouth Town Beach and North Scituate annually. There are numerous motels and rental property conveniently located to the bathing beach areas. Of the total 200 miles in this reach, it is estimated that 50 miles are open for public use and 145 miles are used for private recreation purposes. Shore use and development are shown on plates 60, 62, 64, and 66.

Future Development. The available public recreational use shorefront is insufficient for the heavy demands of an increasing tourist and vacation populace, and it is probable that the state or towns will expand upon the present public recreational beaches. Private developments, both commercial and residential, should no doubt continue to increase within this attractive reach of shorefront easily accessible to a great number of tourists and within a convenient distance of the densely populated Boston megalopolis and other large cities.

Littoral Drift. The predominant direction of littoral drift is dependent on several factors including orientation and configuration of the shorefront in relationship to storms. The wind fetch and predominant direction of storm driven waves plays a major role. Studies for the area have indicated that there appears to be generally a slight predominance of southerly drift along the western exposure of Cape Cod. The north side of the Cape indicates a westerly drift along the outer half and easterly drift along the westerly half. For north-south orientations of the easterly exposure from Cape Cod Canal north indicate southerly drift along shorefront areas fronting sandy dunes and bluffs. Some material nourishes beaches to some degree within areas where groin systems have been constructed or in some locations accrete as trailing spits or tombolos.

29. BOSTON COMPLEX — PEMBERTON POINT THRU BEVERLY, MASSACHUSETTS (NORFOLK, SUFFOLK, MIDDLESEX AND ESSEX COUNTIES)

Physical Characteristics. This sector of shorefront contains the Boston megalopolis extending about 150 miles from Pemberton Point through Beverly. The configuration of this shoreline is a complex system of protruding land features either natural or man-made. The geographical formation includes several deep embayments and numerous offshore islands. The embayments contain several fine harbors including Boston, Weymouth-Fore River, Lynn, Marble Head, Salem, and Beverly.

The geological structure of the area consists of many bay head beaches fronting tidal mud flats, with the islands in many cases being remnants of drumlin formations and composed of unconsolidated glacial deposits. In some locations, through wave-induced processes, former islands have been tied to the mainland as tombolos. Such prominent tombolos within

this area are Winthrop Beach, Lynn, Nahant, and Marblehead Neck. The Nantasket tombolos, as previously discussed, front Hingham Harbor.

The several islands that are in close proximity to the major harbor areas rise rather steeply above the water surface and are generally fronted by sandy beach berms formed through erosion of their unprotected exposed surface. With the exception of Georges Island, location of an old fort now owned by the Commonwealth of Massachusetts, there is an absence of erosion control protection. Much of the exposed sectors of this island contains massive rock protection in a state of disrepair.

The several beach areas along the periphery of the inner complex in general have sand of a texture suitable for use as a bathing beach although several areas include sandfill as placed artificially. Most unimproved beaches have sectors that are quite rocky with natural beach berms deteriorated below protective and recreational use requirements. The seward slopes of most beaches are gentle to flat with the nearshore material being quite fine. It is estimated that of the 150 miles of shorefront in the reach, 100 miles normally contain beaches. Protective improvements behind the beach areas are generally of massive concrete seawall or steel bulkhead construction. There are areas where groin structures, stone or timber construction, are located but which are in various stages of deterioration. Other construction consists of the standard timber or steel bulkhead type fronting commercial and industrial properties of the large city shorefront developments. Much of this type of protection is in a general state of deterioration. The reach is shown on plates 6 and 65.

Shore Ownership. Of the 150 miles of shorefront continue within this reach, it is estimated that 30 miles are publicly owner, 10 miles are Federally owned and the remainder privately owned. The public property consists of several popular municipal or state owned beaches and include one island within the inner harbor complex, namely, Georges Island. This is semi-developed as a recreational historical park with the historical atmosphere stemming from an old fort dating back to the Civil War era. The more prominent beaches administered by the State are Quincy Shore, Winthrop, Revere, and Lynn-Nahant. The portion of shore in Federal ownership consists of several military installations and U.S. Coast Guard property scattered along the shorefront and outer islands. Shore ownership is shown on plate 66.

Shore Use and Development. The shore use is primarily one associated with a heavily industrialized and commercial waterfront type development. This includes ship building, commercial fishing, and storage and shipping activities. The several public beaches within the area are overcrowded, receiving heavy use from a large population. Actual recorded figures available for this reach indicate that up to 10,000,000 visitors annually visit Revere, Winthrop, Quincy and Wessagussett Beaches. Recreational boating is enjoyed within many of the protected harbors. Coastal living is enjoyed by permanent residents living close to the shorefront. Private property consists mainly of commercial and industrial property located within the inner harbor complex of the heavily developed city areas with Logan International Airport being one of the large developments. Coastal residential property is conveniently located throughout the area. Of the total shoreline length within this reach, it is estimated that about 25 miles are open to public use, 80 miles are used for private recreation purposes and 10 miles are presently undeveloped. Shore use and development are shown on plate 66.

Future Development. In this heavily urbanized area within the Boston megalopolis, it is likely that public and privately owned beach areas will be expanded to the maximum protective and recreational use dimensions within economically feasible limits. Shorefront development will continue through redevelopment programs which will include cleanup and repair

of the inner harbor and structural improvements to protective barriers fronting commercial and industrial developments. Residential property will continue to be improved and expanded. Long range planning by the State is directed toward development of the outer island complex for recreational use. In addition to Georges Island, the State has recently agreed to purchase Peddocks Island, the second largest island within the complex, under the U.S. Housing and Urban Development Open Spaces Acquisition Program. This is one of fifteen privately owned shores being considered for purchase by the State as a recreation "land bank".

Littoral Drift. The direction of littoral drift along the beach areas is diversified because of the variation inexposure, the complex configuration of the shorefront, and effect of innumerable structures on wave action. Shorefront areas of the mainland and islands having a general east-west orientation probably experience a predominant westerly drift, while for outer islands exposed with a north-south orientation, the drift is predominantly southerly. Most of the material transported within the littoral current is fine in nature originating within the nearshore areas.

30. BEVERLY, MASSACHUSETTS TO NEW HAMPSHIRE LINE (MIDDLESEX AND ESSEX COUNTIES)

Physical Characteristics. This area, from its southern extremity to Ipswich Bay to the north, is basically an irregular shoreline with rocky headlands containing attractive pocket beaches and is shown on plates 6 and 65. The Cape Ann peninsula, projecting some distance seaward and rising sharply above the ocean, contains most of these small headlands and small beaches and forms a marked separation from the type of geomorphology experienced for the remainder of the shorefront. It is estimated that this area contains the greatest amount of rock along the Massachusetts coast, estimated at about 30 percent within the reach as compared to an overall average probably not exceeding 10 percent rock. Here the shoreline abruptly changes to a continuous system of barrier beaches fronting vast tidal marshes all the way to the New Hampshire state line, interrupted only at the mouth of the Annisquam, Essex, and Merrimack Rivers. These beaches are backed by natural protective dunes except in locations where the area has been modified by development. It is estimated that of the 110 miles of shorefront contained in this reach, 75 miles normally contain a beach. Most of the beaches consist of sandfill exceptionally suitable for recreational purposes. However, the beaches are generally quite narrow and inadequate to serve effectively as protective improvements and to meet desired use requirements. Protective improvements along lower intermediate sections of the shorefront include bulkheads and seawalls. Within the harbor areas at Gloucester and Rockport there are numerous docks and bulkheads fronting the commerical development. There are, in general, no groin structures found along the beaches. At the northern extremity of Plum Island there are several such structures, constructed along the beach fronting the cottage development. Massive structures within the area are confined to large breakwaters and jetties constructed by the State and Federal government. Some major structures are stone breakwaters at Gloucester and Rockport Harbors and stone jetty structures at the mouth of the Merrimack River.

Shore Ownership. Of the 110 miles of shorefront, it is estimated that about 15 miles are publicly owned property, about 10 miles Federally owned and the remainder privately owned. The Federal government and the State of Massachusetts are the principal owners of the public property with only a small portion of public property owned and operated by individual towns. The public property is primarily located in the area extending from the Essex River to immediately north of the Merrimack River. Crane's Beach, owned and administered by the Trustees of Reservations

and Salisbury State Park are two popular recreational areas of northern Massachusetts. The former beach extends northerly of the Essex River for about 4 miles to the mouth of the Ipswich River while the State Park is located immediately north of the Merrimack River. Plum Island, a barrier beach extending for about 8 miles between the Ipswich and Merrimack Rivers, is publicly used except for about 1 mile of privately developed shorefront located along the northern sector. Most of the shorefront of Plum Island is administered by the Federal government and operated as a fish and wildlife refuge. A sector of shorefront at the extreme northern extremity and bordering the south shore entrance of the Merrimack River is owned by the U.S. Coast Guard. A sector of the southern portion of Plum Island is owned by the Commonwealth of Massachusetts and operated as a State Park. Private beaches are scattered throughout the area but located predominantly within the southern one-third. Other private ownerships consist of private residential developments and commercial industrial developments on nearby urbanized harbor areas. Shore ownership is shown on plate 66.

Shore Use and Development. The principal use of the area is seasonal recreation, although there are several scenic areas located at higher elevations where permanent residential developments are located and year-around ocean-front living is enjoyed. All the public-use shorefront is heavily used during the summer recreational season. Such public beaches as Crane's, Salisbury State Park and the Plum Island Wildlife area attract many tourists and vacationists. All available private use beach areas are used by summer residents and vacationists enjoying summer cottage rental type living or living in nearby motels that have access to portions of the private shorefront. Several beaches located along the southern one-third of the reach are developed for semi-public use for town residents only. The heavily urbanized inner harbor areas are used commercially for fishing and recreational boating activities. Of the total shoreline length within this reach, it is estimated that about 20 miles are open to public use and 70 miles are used for private recreation purposes. Shore use and development are shown on plate 66.

Future Development. It is expected that residential development along the southern half of the shoreline will predominate with only a limited increase in recreational use areas because of the private nature of much of the shorefront. the northern half of this region is expected to produce more public recreational facilities to fulfill the needs of an increasing tourist and seasonal vacation populace demanding bathing activities. It is also expected that residential development including summer cottages and permanent homes will continue to expand along areas where room exists for expansion.

Littoral Drift. Because of the rocky nature of much of the southern half of the reach little or no material is available along the backshore for littoral movement. The beaches in this section of the region are located well inland between protruding headlands to a great degree and are therefore protected from the large waves occurring during the more frequent northeast storms. The northern half of the reach that is generally composed of long stretches of sandy beaches is sensitive to littoral processes. Studies made for portions of the shorefront or the adjacent New Hampshire coast indicate that along much of the area there is the predominant southerly movement, however, with a reversal in the predominant direction experienced in some areas as caused by offshore bar configuration that causes the deepwater waves to turn.

31. NEW HAMPSHIRE (ROCKINGHAM COUNTY)

Physical Characteristics. The New Hampshire shoreline, in contrast to the extensive Massachusetts coast, borders the Gulf of Maine and

the Atlantic Ocean for only about 40 miles and is shown on plates 6 and 67. The geological structure of the shoreline varies from extensive lengths of barrier beaches fronting vast tidal marshes along the southern half to large protruding ledge rock headlands containing small pocket beaches along the northern half. It is estimated that fifty percent of the shorefront is of ledge outcrop or massive rock construction. The beach characteristics contrast from sandfill suitable for bathing use to substantial rock strewn sectors, usually the latter having steep backshore and nearshore areas. Two State owned beaches, Hampton Beach and Wallis Sands State Park, were constructed by direct placement of suitable land and hydraulic fill and substantial dry recreational beach area is a result of artificial rather than natural means.

In general, beach areas are of inadequate width to furnish the required recreation use posed by the demands of an increasing tourist and summer populace. Sectors of the shorefront with beach areas naturally stable have beach berm elevations averaging about 15 feet above mean low water with widths in excess of 100 feet behind the mean high water line. Of the 40 miles of shorefront, it is estimated that 25 miles normally contains beaches.

There are a variety of protective measures along the backshore at scattered exposed locations throughout the shorefront. They range from the massive rockfill jetty structures constructed by the State and Federal Government at the entrance to Hampton Harbor to timber or steel bulkheads, rock revetment or concrete seawalls protecting private property or exposed highway sections. Generally, protective structures are located along the open ocean exposure; however, massive stone revetment, constructed by the State of New Hampshire, extends along the northerly outer stretch of Hampton Harbor estuary, and a nearshore breakwater structure also constructed by the State parallels the southerly shorefront within the outer limits of the estuary. Stone revetment, constructed by private property owners is also intermittently located along the south shore.

Shore Ownership. Of the 40 miles of shorefront, about 10 miles are publicly owned, 2.0 miles are Federal property, with the remainder in private ownership. The State of New Hampshire is the principal owner of public property with only a fraction being owned by the towns. The majority of the public use property fronts the state highway.

The publicly owned property is located between Hampton Harbor and the northern half of Rye, New Hampshire, which includes Hampton State Park, adjacent to Hampton Harbor, Hampton Beach, the State's largest recreational beach, about 1 mile to the north and Wallis Sands State Park in the town of Rye. The Federal property, with the exception of the Hampton Beach Coast Guard Station at Hampton North Beach, is located at the northern end of the Town of Rye and Town of Newcastle and Portsmouth. Shore ownership is shown on plate 68.

Shore Use and Development. The principal use of the shorefront is recreational. The public beaches located along the southern half of this coastal area are extensively used during the summer recreational season. Figures available indicate that over 3,200,000 people annually visit Hampton and Wallis Sands Beaches. Private beaches are also heavily used. Many fine summer homes and cottages, intermingled with the beach areas at higher elevations fronting a rocky ledge outcrop shorefront, are enjoyed by the summer residents. Other use of the property is confined to motels and rentals conveniently located to beach areas. The major commercial and industrial shorefront development, usually consisting of warehouses, shipping docks, and piers, are located within Portsmouth Harbor. Of the total shorefront length within this reach, it is estimated that about 8 miles are open to public use and 30 miles are used for private recreational purposes. Shore use and development are shown on plate 68.

Future Development. It is expected that with the ever increasing demands for recreational use beaches that the publicly owned shorefront

will be developed through beach widening commensurate with the salt water bathing needs including additional state parks. It is also expected that residential development will continue to expand.

Littoral Drift. Generally the predominant direction of littoral drift along the New Hampshire coast is from north to south, although the orientation of some beaches probably modifies this to some degree, sometimes, with no predominant direction of alongshore drift indicated. In all areas there is an inadequate supply of natural material to nourish the beach with the net result being an offshore loss of material from the beaches.

32. NEW HAMPSHIRE STATE LINE TO KENNEBEC RIVER, MAINE (YORK, CUMBERLAND AND SAGDAHOC COUNTIES)

Physical Characteristics. This sector of shorefront contains the State's major sandy beach areas and is shown on plates 6 and 69. The configuration of most of the shoreline is far less pronounced by the deep rock embayments as found within the area northeast of the Kennebec River, although this type of condition appears in the Casco Bay area at the northeastern extremity of this reach where a physiological transition from the lower sandy beach and marsh area to the rockbound shorefront begins to occur. It is estimated that south of Portland no more than 30 percent is rocky or of ledge rock construction, while the remainder of the reach northeast of Portland increases to 50 percent rock outcrop. Many of the beaches are crescent-shaped, contained between projecting rocky headlands. Such popular public use beaches as York, Ogunquit, Wells, Kennebunk, Old Orchard, and Crescent are located in this area, not to mention substantial stretches of sandy beach fronting attractive private cottage developments. At the northern extremity of this area Popham Beach extends for some distance west of the Kennebec River.

In general, the beaches consist of good quality sand suitable for bathing purposes but erosion, coupled with an inadequate supply of natural beach building material, has resulted in a reduction of beach width above the normal tide level affording a dry beach area below the recreational use requirement of an increasing summer populace. Of the 600 miles of shorefront in this reach, it is estimated that 50 miles normally contain beaches.

There are a variety of protective improvements constructed by State, Federal, and local interests. Generally, the type of protective improvements is tailored to the storm exposure requirements and financial capabilities of the property owner. Frequently, therefore, the financial limitation results in a less than adequate structure than would be desirable. The structures include a variety of backshore protection such as timber and steel sheet pile bulkheads, a stone revetment, concrete seawalls, and precast concrete units. The only massive breakwater type construction within the area is that provided by the Federal Government in cooperation with the State and local interest at such locations as at the entrance to Wells Harbor and the Saco River where massive stone jetties were constructed as necessary requirements for two navigation projects.

Shore Ownership. Of the 600 miles of shorefront, it is estimated that 50 miles are publicly owned, 10 miles are Federal property with the remainder of the property in private ownership. The shoreline is primarily privately owned with limited areas owned by the State. Much of the public use property fronts the State highway. Publicly owned property is at a premium representing only about one percent of the reach of shoreline, generally consisting of recreational beach areas owned by the State or towns. The State has developed two fine State parks within the area, Crescent State Beach on Cape Elizabeth and Popham State Park at Phippsburg. Some of the major publicly owned beach areas are at Ogunquit, Wells,

Kennebunkport and Old Orchard. Private ownership consists of summer and permanent residential developments scattered throughout the reach. Commercial property consisting mostly of motels and other rental properties located at or conveniently to extensive public or private recreational beach areas. Industrial and commercial property are located within the Portland Harbor complex and other heavily populated towns within the reach. This type of property generally consists of shipbuilding companies, fishing industries with associated piers and docks. Federal property consists of a U.S. Coast Guard Lighthouse located on Cape Neddick Nubble in York Village and a Navy Reservation located at the entrance to the Salmon Fall River at Kittery. The Portland area, including the outer islands have several military installations located within the complex. Shore ownership is shown on plate 70.

Shore Use and Development. The principal use of the shorefront is private recreational. The available public beaches located throughout the area are widely used by tourists, summer and permanent residence during the summer recreational season. Many fine summer and permanent residential developments are located along the entire shore, including large estates with many overlooking the scenic rocky ledge outcrop shorefront at scattered locations, while others enjoy the privacy of their own recreational beach. Beach areas, both private and public, are heavily used throughout the entire reach of shore. Other use of the property is commercial and industrial. The former being predominantly seasonal rental type or recreational boating developments with the latter being large shipbuilding and fishing industries at a few heavily developed city or village complexes. Of the 600 miles of shorefront, it is estimated that 8 miles are in public recreational and 522 miles used for private recreation, 10 miles non-recreational use (industrial and commercial complexes within the heavily urbanized areas) and 60 miles undeveloped, (outer island and extensive shorefront along projecting headlands.) Shore use and development are shown on plate 70.

Future Development. With the ever-increasing demands for additional recreational public use beaches, it is expected that publicly owned shorefront will be developed through beach widening and raising commensurate with the salt water recreational needs within the area. It is also expected that residential development will continue to expand throughout the entire region. There will be an increase in attractive rental type motel complexes to satisfy the needs of an increasing tourist and summer vacation populace.

Littoral Drift. The littoral drift, as studied in a few beach erosion control studies made for beaches in the York-Old Orchard area, indicates that in a large part the predominant direction varies depending upon the orientation of the shoreline. The drift is generally from north to south, along straight reaches. However, some beaches in the area have no predominant direction of alongshore drift, such as at pocket beaches adjoining picturesque rocky shores. The rocky nature of much of the reach, with its manmade structures protecting erodible areas of backshore, result in only a limited amount of beach-building material movements.

33. KENNEBEC RIVER, MAINE TO CANADA (LINCOLN, KNOX, WALDO, HANCOCK AND WASHINGTON COUNTIES)

Physical Characteristics. This reach of shorefront as shown on plate 6 is quite often described as the "down east" rockbound coast of Maine, nationally known for its picturesque beauty. The geological structure is, in general, massive ledge outcrops topped with thin overburden usually with coniferous tree growth. It is estimated that of this 1900 miles of exposed shoreline, only 10 miles normally has a beach or consists of erodible material with the remainder, in excess of 90 percent, being formed of ledge outcrop or massive boulders. The

configuration of the shorefront is very irregular consisting of numerous embayments separated by protruding headlands in some cases extending some distance seaward. There are also numerous nearshore islands scattered along the coast. These islands are generally quite small, becoming somehwat larger in the Penobscot Bay-Bar Harbor area. Here, Mount Desert Island, at Bar Harbor, rises in excess of 1500 feet above mean sea level. The backshore as a whole, therefore, generally is afforded a natural protective front by the ledge outcrops rising above storm wave runup. Infrequently, there are locations exposed to wave attack, but usually these areas are fronted by a boulder strewn beach affording substantial natural protection against storm-driven waves.

There are, therefore, only scatered locations at vulnerable erodible property quite often consisting of artificially filled embankments such as coastal highways or public parking areas at town docks or private marinas. There are a few pocket beaches widely scattered along this predominantly rocky coast. Protective structures usually consist of stone revetment or timber or sheet-pile bulkheads.

Shore Ownership. Of the estimated 1900 miles in this reach of shorefront about 10 miles are publicly owned, 10 miles are Federal property with the remainder in private ownership. Widely scattered State parks include most of the State-owned public use property with other public property being that fronting State or town-owned coastal highways and a very few small beach areas. The private property includes the urbanized areas of coastal towns with scattered residential development located throughout. Much of shorefront, although undeveloped, is in private ownership. Federal property consists of the Arcadia National Park area at Bar Harbor and vicinity.

Shore Use and Development. Much of this area where accessible by coastal roads is used for coastal living and tourist use. This rocky shoreline of Maine is nationally known for its majestic beauty with fir tree forests extending along much of the shoreline to add to the scenic splendor of the ledge and rock shoreline with waves breaking along the backshore. There are many natural embayments used by numerous small recreational and fishing boats as sheltered anchorages. Many of these embayments have been or are being developed privately or by towns with parking and docking facilities. Of the 1900 miles of shorefront contained in this reach, it is estimated that 5 miles are publicly used, 445 miles are of private recreational use and 1200 miles are undeveloped.

Future Development. Along this reach of shorefront, it is believed that the State and towns will continue to develop much of the area for additional parks and viewing points. The many natural embayments will be provided with facilities for increased recreational boating use. As highways are improved and with the increasing demands for summer residential living, there will likely be an increase in development of seasonal residential cottages and homes, and commerical rental properties.

Littoral Drift. There have been no detailed studies within this area upon which to positively define the littoral drift characteristics. There is a great lack of sandy beach area. Those existing are confined within sheltered embayments where isolated small marsh type areas are sometimes found. The littoral movement in these areas is probably quite small with very little predominance of direction indicated. These beaches remain in a somewhat near stable condition but experience slow offshore losses, being maintained by the slow landward encroachment of erosion of the soft backshore material.

C.

SHORE HISTORY

C. SHORE HISTORY

1. VIRGINIA-CAROLINA LINE TO ISLE OF WIGHT COUNTY LINE

General. With few exceptions, the 27 miles of ocean shoreline from the North Carolina state line to Cape Henry have exhibited alternating advancement and recession since the earliest surveys of record. West of Cape Henry, to Little Creek, the shoreline has shown alternate periods of erosion and accretion with the overall trend being one of gradual accretion. Between 1891 and 1916 the 4.8 mile section of shoreline between Lynnhaven Inlet and Little Creek eroded at an average rate of 12 feet per year. Since then, the overall trend has been one of gradual accretion. Material placed artificially to rebuild the Atlantic Ocean shoreline at Sandbridge, Virginia Beach proper, and North Virginia Beach after the 6-8 March 1962 storm has continued to erode at rates comparable to those experienced historically. Except for a few reaches of beach accreting, there has been a general recession of the entire shoreline.

Based on the latest complete survey of 1968 for the reach from the state line to the Cape Henry Lighthouse, the 27.0 miles of beachfront along the Atlantic Ocean was undergoing an average annual rate of erosion of 0.72 feet, which is equivalent to approximately 100,000 cubic yards per year. This loss is offset by almost equivalent accretion on the 9.7 miles of bay shoreline between Cape Henry Lighthouse and Little Creek. Based on complete shoreline surveys of the 4.9-mile reach between the lighthouse and Lynnhaven Inlet, made in 1962, and the 4.8 miles of beach between Lynnhaven Inlet and Little Creek, made in 1946, the average annual rate of accretion was 1.98 feet, which is equivalent to slightly more than 100,000 cubic yards per year.

The 11-mile segment of shoreline from Little Creek Inlet to Willoughby spit has been relatively static to change in recent years. Erosion has removed material from this reach during storm periods, but natural return has usually occurred.

The remaining shoreline in the reach, except for several miles of undeveloped land in Nansemond County, is developed to the water's edge and is not subject to erosive processes.

Critical Erosion Areas. The shore areas where erosion presents a serious problem and the possibility of justification of remedial action exists are those areas where the shores are most highly developed, and those areas which now and in the future will be essential as protective barriers, preventing adverse changes in important ecosystems or serving as significant refuges. Of the total shore frontage of 70 miles, the length of the critical erosion areas totals about 20 miles; about 22 miles have a history of erosion but the problem is not critical. The remaining frontage, 28 miles, has a history of stability or accretion. Critical problem areas are shown on plate 7.

2. ISLE OF WIGHT COUNTY LINE TO NEW KENT COUNTY LINE, VIRGINIA

General. The entire southern shoreline of the James River is experiencing some degree of shore erosion. Almost the entire shoreline shows a near vertical profile, increasing in height moving up river. Shoreline recession has averaged approximately 15 feet in the last 10 years in Surry County and 15 feet in the last 30 years in Isle of Wight County.

On the northern shore of the James River the shoreline of Hampton, facing the Chesapeake Bay is relatively stable, experiencing little to no erosion.

In Newport News, isolated areas of critical erosion, non-critical erosion and non-erosion exist, all intermingled.

In James City and York counties any problems relating to erosion have remained unrecorded and/or considered negligible, with the exception of Jamestown Island, in James City County, where erosion is present. Otherwise these country shorelines can be considered fairly stable as indicated by historical shore changes.

Critical Erosion Areas. Critical erosion areas in the reach include the shoreline of the James River, and 6.5 miles of shore in Newport News and are shown on plates 7 and 9.

3. GLOUCESTER COUNTY LINE TO KING GEORGE COUNTY LINE, VIRGINIA

General. Shore erosion in this reach of shore, as a whole, is not too alarming. It is the fact that the rate varies from site to site and from year to year that adds so much to the seriousness of the problem. So often the most desirable locations for homes and other developments are the most vulnerable sites.

Beach erosion rate along the south bank of the Potomac for the 1906-1956 period averaged approximately 2.4 feet per year. Bank erosion along the south bank of the Rappahannock during the same period averaged 2.9 feet per year while the north bank eroded at an average rate of 3.4 feet per year.

Critical Erosion Areas. Broadly speaking, critical erosion areas occur opposite the greatest fetch distances and are shown on plates 9 and 11.

4. EASTERN SHORE AND BARRIER ISLANDS OF VIRGINIA

General. In general, erosion along this reach of shoreline has been severe, with the barrier islands suffering the greatest material losses. Between 1850 and 1962, Wallops Island lost 6.3 feet a year, Metomkin Island surrendered 15 feet a year, and Cedar Island gave up 16 feet each year. To the south, surveys revealed that Parramore, Hog, and Cobb Islands are building seaward in their northern portions. The southern portions of these islands, however, have experienced dramatic erosion, as much as 50 feet a year on Hog Island.

Wreck, Ship Shoal, and Myrtle Islands, off the southern tip of Northampton County, have had an irregular and shifting erosion history. The net loss for Wreck Island has been about 44 feet a year, while Smith Island experienced a fairly uniform retreat of 25 feet a year. The only island that showed strong net gains was Fisherman, which has grown from a simple shoal to a stable piece of land. This island, off the tip of Northampton County, serves as a stepping stone for the northern end of the Chesapeake Bay Bridge-Tunnel.

The material composing Fisherman Island is derived from eroded areas further up the peninsula and transported there by longshore currents along both Chesapeake Bay and the Atlantic Ocean.

Historical surveys of the Chesapeake Bay shores of Accomack and Northampton counties indicate a general trend of erosion here averaging 5 feet annually. However, due to the absence of development along this shoreline, erosion is not considered as critical as that occurring along populated oceanic beaches.

Critical Erosion Areas. Critical erosion areas found in this reach include the entire windward and segments of leeward shores of all the barrier islands except Fisherman's. Although these islands are presently undeveloped, they serve as a protective barrier for the mainland and should be preserved. Erosion of the mainland shoreline facing Chesapeake Bay is considerable, but generally is not critical to development. Critical erosion areas are shown on plate 11.

5. MARYLAND

General. The shore erosion considered in this reach is caused by wind-generated waves and their associated currents. The erosive effects of tidal currents are also considered when those currents contirubte to the erosion problem. Erosion is normally a gradual process, although storm-generated waves greatly accelerate it.

Extensive recession of the mean high water shoreline has occurred along the shores of Chesapeake Bay and the Atlantic Ocean. A detailed study published in 1949 (Singewald and Slaughter) of Maryland's shoreline changes over the period 1845-1942 outlined rates of annual linear recession and acreage lost for all tidewater counties. The accompanying tabulations, furnished by the Maryland Geological Survey, summarize the net results of erosion or

deposition of shore features. The net loss of land amounted to about 25,000 acres over the period of record.

The maximum net loss by county, including islands, over the period of record is shown in Table 1C. Table 1C also depicts, by county, the annual rate of loss in acres per mile. Not surprisingly, Dorchester County leads, with Talbot County second; but Wicomico County, with a relatively short stretch of measured eroding river shoreline, is third.

The Western shore, with about 30 percent of the total miles of shoreline measured, experienced about 25 percent of the net loss of tidal shore property. The Eastern Shore, with 70 percent of the total miles of shoreline measured, experienced 75 percent of the net loss of tidal shore property. Dorchester leads all tidewater counties, with a loss of about 30 percent of the total. Somerset and Talbot Counties are second and third. Since the net loss of island area accounts for 30 percent of total net loss in the Bay, a separate table of island erosion statistics is presented in Table 2C. Again, Dorchester County leads, accounting for 10 percent of the total net loss.

SHORE EROSION IN MARYLAND

1845-1942

Table 1C

County	Time Interval Years	Miles Measured	Erosion Acres	Deposition Acres	Net Loss Acres	Annual Rate of Loss Acres/mi./yr.
Anne Arundel	89	138	1,931	295	1,636	.14
St. Mary's	82	127	1,801	267	1,534	.15
Harford	94	81	1,101	131	970	.13
Baltimore	89	67	893	82	811	.15
Calvert	90	69	893	232	661	.11
Charles	61	92	415	198	217	.04
Prince Georges	81	21	107	35	72	.04
Western Shore Total	84	595	7,141	1,240	5,901	.11
Dorchester	94	333	7,319	433	6,886	.22
Somerset	93	233	3,555	251	3,304	.15
Talbot	93	189	3,435	213	3,222	.18
Queen Annes	96	129	2,026	247	1,779	.14
Kent	96	100	1,302	122	1,180	.12
Cecil	94	78	843	171	672	.09
Wicomico	93	35	552	9	543	.17
Caroline	93	13	128	2	125	.10
Eastern Shore Total	94	1,110	19,160	1,449	17,711	.16
Worcester (Atlantic Coast)	93	31	861	344	517	.17
Worcester (Other)	92	203	2,209	1,626	583	.03
MARYLAND TOTAL	90	1,939	29,371	4,659	24,712	.14

ISLAND SHORE EROSION STATISTICS OF MARYLAND

1845-1942

Table 2C

County	Time Interval Years	Miles Measured	Erosion Acres	Deposition Acres	Net Loss Acres	Annual Loss Acres
Harford	95	14	267	14	253	2.7
Baltimore	88	7	195	2	193	2.2
St. Marys	77	12	201	49	152	2.0
Charles	75	4	54	5	49	.7
Anne Arundel	89	3	29	5	24	.3
Calvert	94	2	3	0	3	.03
Western Shore Total	86	42	749	75	674	7.8
Dorchester	94	109	2,646	150	2,496	26.5
Somerset	93	120	1,925	130	1.795	19.3
Talbot	93	26	1,643	51	1,595	17.1
Kent	96	19	289	23	266	2.8
Queen Annes	96	7	152	4	148	1.5
Eastern Shore Total	94	281	6,655	358	6,297	66.9
Worcester	92	55	864	232	632	6.8
ISLAND TOTAL	90	378	8,268	665	7,603	84.4

Surveys indicate that, since the earliest year of record (1850), the shoreline of Ocean City has receded except for the area between 10th Street and the inlet where construction of the north jetty in 1934 impounded littoral material causing an oceanward advance of the shoreline in this reach. The beach immediately adjacent to the north jetty has a width of about 800 feet. The shoreline north of 10th Street to the Maryland-Delaware line has eroded at an average rate of two feet per year.

Surveys of Assateague Island, Maryland, covering the same period indicate a general trend of erosion along the Maryland portion of Assateague Island averaging three feet per year. The jetties protecting the inlet have interrupted the southerly movement of littoral material, resulting in increased erosion of the northern portion of the island. The rate of erosion of the northern five-mile reach of the island is estimated at 35 feet annually. South of this reach, Assateague Island has eroded at a fairly uniform rate of about one-half foot annually.

Critical erosion areas. As shown in Table 1C, about 1,705 miles of Maryland's Chesapeake Bay shoreline are subject to erosive forces. Not surprisingly, shores experiencing severe erosion in the Chesapeake Bay generally front the Bay. The reaches considered critical in this study, total 150 miles as shown on the accompanying plates and generally have historical erosion rates between 2 and 30 feet annually. An estimated 10 percent or 200 miles of the Bay shoreline is considered as stable, 150 miles as critical erosion, and the remaining 1,355 miles considered as non-critical erosion areas. The 150 miles of critical erosion is divided among the following counties:

7.6 miles	Anne Arundel County
5.1 miles	Baltimore County
6.0 miles	Calvert County
1.0 mile	Charles County
1.0 mile	Harford County
38.0 miles	St. Mary's County
3.0 miles	Cecil County
21.0 miles	Dorchester County
7.0 miles	Kent County
15.3 miles	Queen Annes County
13.0 miles	Somerset County
32.0 miles	Talbot County

The entire 31-mile Maryland-Atlantic coastline, except for the one-mile reach immediately north of the inlet, is considered critical. The northernmost five miles of Assateague Island have experienced the worst erosion, about 35 feet annually since 1934. The one-mile reach of Ocean City immediately north of the inlet is an area of accretion. About 145 miles of the shoreline along the inner bays behind the barrier islands are considered non-critical erosion areas, while 58 miles are considered stable.

Critical erosion areas are shown on plates 13, 15, 17, and 19.

6. CAPE HENLOPEN TO FENWICK ISLAND, DELAWARE

General. Shore erosion in this area is due to the action of waves, currents, swells, winds, tides and storms. The erosion is normally a gradual process, with material being removed by the daily action of littoral forces. However, erosion is greatly accelerated during storms. The existence of the nodal area at Bethany Beach has resulted in the constant recession of the shoreline in this area.

Except for the accretions at Cape Henlopen, a recession of the shoreline along the Atlantic Coast of Delaware has occurred over the period of record. It is believed that the principal sources of the accretion at the Cape are the eroding beaches to the south. Between 1834 and 1964 the annual erosion in the reach from the Cape to Indian River Inlet totalled 470,000 cubic yards (above and below mean low water). Of this total, approximately 138,000 cubic yards, or approximately one-third of the total, had been deposited on the Cape annually, while the remaining two-thirds is believed to have been lost to the shore areas offshore of the Cape.

Erosion had been severe in the one-half mile reach immediately north of the Indian River Inlet jetties even before their construction. However, the rate of loss has been accelerated since the jetties were constructed in 1939. The steepening offshore slopes in the vicinity of Rehoboth Beach are an indication of the northward progression of the erosion problem. The average annual rate of beach loss above mean low water has been estimated at 52,500 cubic yards in the one-half mile adjacent to the north jetty and 22,500 cubic yards in the problem area at Rehoboth Beach, based on surveys for the period 1954 to 1964.

At Bethany Beach the average annual loss of beach material above mean low water has been estimated at 69,000 cubic yards. Because of the nodal zone, the problem of beach loss is extremely serious in this area, since there is essentially no supply of drift.

The shoreline of Cape Henlopen has been moving northward and westward as the ocean shore has been eroding. The northern tip of the Cape is presently about 3,850 feet north of its 1843 location. Erosion predominates along the ocean shore of Delaware, particularly along the two miles extending southward from the tip of the Cape. Between 1843 and 1964 the net recession was 7 to 10 feet per year in that reach. From this reach of Cape Henlopen to Rehoboth Beach the shoreline has continually receded, averaging 6 feet per year between 1843 and 1964. From Rehoboth Beach to a point 1.75 miles north of Indian River Inlet, the shoreline receded 4 feet per year between 1843 and 1929, remained generally stable between 1929 and 1954 and advanced seaward 2 feet per year between 1954 and 1964. The accretion between 1954 and 1964 reflects the beach fill placed in 1957, 1962 and 1963. The

1.75 miles of shore immediately north of Indian River Inlet has experienced both erosion and accretion since 1843. The net change has been an erosion of this reach. The rate of erosion in this area has been increasing since the completion of the inlet jetties in 1939. Between 1843 and 1939 the shoreline recession in the one-mile reach just north of the inlet averaged 7 feet per year, while between 1939 and 1954 the rate of recession was 21 feet per year.

The shoreline between Indian River Inlet and the Delaware-Maryland State Line has had periods of erosion and accretion since 1843. Between 1843 and 1929 the shoreline along this entire reach retreated landward at an average rate of about 3 feet per year. Between 1929 and 1954 erosion was comparatively slight. The shoreline immediately south of Indian River Inlet has been accreting since construction of the inlet jetties in 1939. Between 1954 and 1964, despite considerable emergency beach and dune fill following the severe storm of 6-7 March 1962, most of the reach from Bethany Beach to the Delaware-Maryland State Line experienced a net recession of the shoreline averaging 6 feet per year.

As stated previously, Bethany Beach is the most critical section in this area. Severe erosion occurs at this location even during moderate storms.

Critical Erosion Areas. With the possible exception of a one-mile reach immediately south of the Indian River Inlet, the entire ocean coast of Delaware is considered to be a critical erosion area. Thus, of the total frontage of 24.5 miles, 23.7 miles are considered critical. Reaches of critical and non-critical shore erosion are shown on Plate 21.

7. REHOBOTH, INDIAN RIVER AND LITTLE ASSAWOMAN BAYS, DELAWARE

General. As stated previously, where erosion of the shoreline has occurred, it has usually been due to the action of storm or wind-generated waves and currents. Some areas adjacent to deep channelized reaches, such as along the inner (bay) end of the Indian River Inlet, experience erosion resulting from the daily action of tidal currents. Another cause of localized erosion has been the clearing of woodlands along the shore to make way for new developments, leaving the shoreline vulnerable to wind and wave action.

Available data on the extent of erosion is minimal. Severe erosion has been experienced along the shores west of the inner (bay) end of the Indian River Inlet, partly due to the daily action of tidal currents. A summary tabulation of the shoreline condition along the entire reach is as follows:

	Miles
Reaches of critical shore erosion	2
Reaches of non-critical shore erosion	0
Non-eroding (stable or accreting) reaches	118

Reaches of critical and non-critical shore erosion are shown on Plate 21.

Available surveys and information on erosion in the bay areas are very limited. Examination of U.S. Coast and Geodetic Survey Charts of the bay areas dating to 1954 does not reveal any significant changes in shoreline configuration except in the areas to the west of the west end of the Indian River Inlet.

Critical Erosion Areas. The only known erosion areas that are considered critical are the previously discussed areas west of the Indian River Inlet, the total length of critical shoreline is approximately 2 miles.

8. DELAWARE RIVER AND BAY SHORE OF DELAWARE CAPE HENLOPEN TO WILMINGTON

General. Erosion of the shore in the study area results from the action of storm tides, tidal currents, wind, waves and swells. The reach above Pickering Beach lacks sandy beaches and where erosion occurs, it is usually the result of

local bank erosion, usually during storm or abnormal tide conditions. The beaches between Pickering Beach and Lewes are on the open bay and experience the daily action of littoral forces similar to those of the open ocean, but to a lesser degree. As is true on the ocean shore, erosion of these beaches is accelerated during storms.

Little factual information is available on the erosion rates actually experienced in the reaches north of Pickering Beach. A study of U.S. Coast and Geodetic Survey Coast Charts dating to 1943 does not reveal any significant change in the overall shoreline to the north of Pickering Beach. Along the beaches between Pickering Beach and Lewes, erosion of the shoreline, with few exceptions, has been continuous since earliest surveys dating to 1843. During the 10-year period from 1954 to 1964, the loss of beach above mean low water between Kitts Hummock and Lewes totalled 532,000 cubic yards annually. A summary tabulation of the shoreline condition along the entire reach is as follows:

	Miles	% of Total
Reaches of critical shore erosion	2	2
Reaches of non-critical shore erosion	31	38
Non-eroding (stable or accreting) reaches	49.0	60

Reaches of critical and non-critical erosion are shown on Plates 23 and 25.

A study of U.S.C. & G.S. Charts of the reach above Pickering Beach does not reveal any significant shoreline erosion in this area. The reach of shore between Pickering Beach and Lewes experienced a net landward recession of the shoreline since 1843, averaging from 3 to 9 feet per year between 1843 and 1964. Volumetric losses of beach areas above mean low water between 1954 and 1964 are summarized in the following tabulation.

Reach	Length (miles)	Net Annual Loss of Beach Above Mean Low Water (cubic yds.)
Kitts Hummock to St. Jones R.	2.8	3,000
St. Jones River to Mispillion R.	10.5	142,000
Mispillion River to Roosevelt Inlet	14.9	293,000
Roosevelt Inlet to Cape Henlopen	3.6	94,000
Total	31.8	532,000

Critical Erosion Areas. Of the total 81.5-mile length of shoreline in the study area, 2 miles are considered to be critical.

9. DELAWARE RIVER AND BAY SHORE OF NEW JERSEY CAPE MAY POINT TO PENNS GROVE

General. Where shore erosion has occurred along the bay frontage it has resulted mostly from the action of storm tides, tidal currents, winds, waves and swells. Where erosion of the shoreline in marsh areas has occurred it is often the result of local bank erosion during storms, rather than to the effects of the day-to-day action of littoral forces. Beach areas are subject to the action of continuous littoral forces, however, most erosion has occurred during storms and wave activity.

Little factual information on erosion rates is readily available. Due to the largely undeveloped nature of the area, critical erosion areas constitute a relatively minor portion of the total shoreline. A study of U.S. Coast and Geodetic Survey Coast Charts dating to 1939 does not reveal any significant change in the overall shoreline. Changes in the configuration of the mud flats have occurred in some areas, and erosion of the mean high water line in the beach areas along the exposed Bay section in the southern part of the study area has occurred.

The best information on historical shoreline changes is available for the reach of the Bay

shore between the Cape May Canal and the Maurice River. This is the most exposed section of the River and Bay shore of New Jersey and has consequently experienced the most erosion. Surveys dating to 1842 indicate that the shoreline in this area had receded as much as 13 feet per year at one location. The erosion rate along most of this reach, however, averaged less than 4 feet per year during the 115-year period from 1842 to 1957. Some areas experienced a net bayward advance of the shoreline of between 1 and 3 feet per year during the same period.

Critical Erosion Areas. Of the total 85-mile length of shoreline between Penns Grove and Cape May Point, 4.5 miles are considered to be critical. Erosion has occurred along an additional 26.5 miles of the shore, but in areas that are not developed. This erosion is not considered critical. The remaining 54 miles of shore, while experiencing some local erosion, is considered essentially stable. Beaches of critical and non-critical erosion are shown on Plates 29, 31, and 33.

10. ATLANTIC COAST OF NEW JERSEY MANASQUAN INLET TO CAPE MAY POINT

General. Shore erosion in this area is due to the action of waves, currents, swells, winds, tides and storms. Rip currents cause severe erosion in some localities, while tidal currents in the various unprotected inlets produce highly unstable conditions at the ends of the barrier islands. The erosion is normally a gradual process, with material being removed by the daily action of the littoral forces. When the rate of removal is greater than the amount of drift being supplied, the result is a net recession of the shoreline. Erosion is greatly accelerated during storms.

Surveys dating from 1839 show that the shorelines in the reach from Manasquan Inlet to Cape May Point have experienced periods of both recession and seaward advancement. The paragraphs below discuss the shoreline changes along the major reaches of shore. A summary tabulation of the shoreline condition along the entire reach is as follows:

	Miles	% of Total
Reaches of critical shore erosion	73.7	76
Reaches of non-critical shore erosion	12.0	13
Non-eroding (stable or accreting) reaches	11.3	11
Totals	97.0	100

Reaches of critical and non-critical shore erosion are shown on Plates 35, 37, 39, and 41.

Point Pleasant Beach to Barnegat Inlet—Surveys dating from 1839 indicate that this reach of shore has experienced periods of both recession and seaward advancement of the mean high water shoreline. The most significant shoreline changes, from 1932 to 1953, were a seaward movement of up to 200 feet between Mantoloking and Chadwick and about 100 feet at Seaside Heights. At both of these locations the shoreline in 1953 was at its maximum seaward location for the period of record. Between Bay Head and Berkeley, shoreline changes from 1953 to 1965 ranged between maximum movements of 140 feet (12 ft. per year) seaward and 195 feet (16 ft. per year) landward. This movement was equivalent to a complete loss of the 1932 to 1953 accretion between Mantoloking and Chadwick. With the exception of the area immediately north of Barnegat Inlet, the shoreline from 1932 to 1953 for the remaining reaches receded, with a maximum recession of 150 feet (7 ft. per year). Between 1953 and 1965 a recession of the shoreline occurred along most of the reach between Bay Head and Barnegat Inlet. Between 1953 and 1965, shoreline movements varied from a 285-ft. recession just north of the Barnegat Inlet north jetty and a 160-ft. seaward advance along Island Beach.

Long Beach Island—The northeast tip of Long Beach Island experienced rapid erosion prior to construction of protective structures. (A program of bulkhead and groin construction

was undertaken by the State in 1926 to protect the historic Barnegat Lighthouse and the Barnegat Inlet Jetties were constructed in 1939 and 1940). This end of the island receded 37 feet per year between 1840 and 1899, 16 feet per year between 1899 and 1915 and 19 feet per year between 1915 and 1936. This shoreline has been relatively stable since 1936, due to the protective structures. Except for a short reach including the lower end of Brant Beach and Beach Haven, the entire island has experienced a net recession of the mean high water shoreline between 1840 and 1965. The upper half of the island (above Brant Beach) experienced a net recession averaging about 15 feet per year, or about 1,875 feet during the 125-year period. Between the lower end of Brant Beach and Beach Haven the shoreline advanced at an average rate of about 3 feet per year, or about 375 feet. The greatest net recession occurred at the southwestern end of the island below Beach Haven, where the shoreline recession averaged 18 feet per year, or about 2,250 feet during the 125-year period. The radical changes at this end of the island are largely the result of the tidal forces at the uncontrolled Little Egg Inlet.

Pullen Island (Little Beach)—Surveys dating from 1840 show that this uninhabited island has been subjected to many changes in shape and area resulting from alternate erosion and accretion. Between 1955 and 1965 the northeastern tip of the island receded a distance of about 700 feet, while the southeastern tip advanced a distance of over 3,000 feet. The shoreline along the island generally receded during the 10-year period.

Brigantine Island—Surveys dating from 1840 show radical changes in the locations of the mean high water shoreline at the northeastern end of the island at Brigantine Inlet and at the southwestern end of Absecon Inlet. The northeast tip of the island receded 3,400 feet (110 ft. per year) between 1840 and 1871, advanced seaward 1600 feet (57 ft. per year) between 1871 and 1899, and receded 2,300 feet (110 ft. per year) between 1899 and 1920. Little change occurred between 1920 and 1944. By 1955 the tip had advanced 600 feet (54 ft. per year) and then again receded 200 feet (20 ft. per year) during the next 10 years.

The southwest end of the island has been accreting since the beginning of construction of the Brigantine jetty in 1952. As a result of the jetty construction the shoreline at this end of the island has advanced appreciably. Between 1955 and 1965 it advanced 800 feet, or 80 feet per year.

Movements of shore line along the ocean frontage of Brigantine have been variable since 1840. The net change between 1840 and 1965 has been a general recession averaging about 5 feet per year along the upper end and about 10 feet per year near the lower end but above the accretion area at the jetty. The central area experienced a net shoreline advancement averaging about 7 feet per year.

Absecon Island—The ocean shoreline of Absecon Island has generally advanced since 1840 averaging 5 feet per year between 1840 and 1965, although erosion has occurred in recent years. The inlet frontage at Absecon Inlet receded and the southwestern end of the island at Longport experienced radical changes in location until protective structures at each of the two locations stabilized these shorelines. The inlet frontage at Absecon Inlet receded about 600 feet (6 ft. per year) between 1841 and 1936, but since 1936 it has been relatively stable due to the construction of bulkheads and groins along that frontage. An 1841 survey showed the southwestern tip of the island to be located about 3,600 feet northeast of its 1965 location. Between 1841 and 1886 this tip advanced southwesterly through a distance of more than 7,200 feet and completely enveloped a sand bar located in the central portion of Great Egg Harbor Inlet. Subsequently this end of the island receded steadily until it was stabilized by groins and revetments constructed in 1917 and rehabilitated in 1953.

Peck Beach—The northeast tip of Peck Beach at Ocean City had undergone a net

advance in the northeasterly direction of about 4,800 feet between 1842 and 1963. Serious erosion of the tip was experienced between 1924 and 1951 but was arrested by construction of groins and a seawall during that period. The greatest rate of advance occurred between 1955 and 1963 when the tip advanced about 900 feet, or 112 feet per year.

Along the ocean shore, erosion constitutes a major problem at Ocean City. Major erosion occurred between 1944 and 1955 in the reach between Surf Road and 7th Street. Surveys made in 1963 indicate that this reach continues to be a major erosion area and that the problem has advanced downcoast to about 18th Street. Beach fill placed between Surf Road and 7th Street in 1952 was not retained and the 1955 and 1944 shorelines were nearly coincident. Approximately 1,618,000 cubic yards of sand fill were added during 1959 in the reach extending from a point 1,000 feet downcoast from Surf Road to about 15th Street. However, the 1963 high water shoreline in most of this reach was coincident with the 1955 location, indicating that the fill had eroded. The present high water line is landward of the boardwalk between 2nd and 7th Streets. The shoreline to the north of 2nd Street receded about 100 feet between 1955 and 1963, or about 12 feet per year.

Downcoast of 18th Street, the remainder of the ocean coast has generally advanced seaward since at least 1935. The average rate of advancement between 1935 and 1963 was about 8 feet per year.

The southwest tip of Peck Beach advanced approximately 1,200 feet to the southwest between 1936 and 1955. By 1963 the tip retreated approximately 200 feet to the northeast.

Ludlam Beach— The northwest tip of Ludlam Beach generally advanced seaward prior to 1955. Between 1955 and 1963 the tip receded westward about 1,300 feet, or 162 feet per year. The shoreline along nearly the entire length of Ludlam Beach receded between 1955 and 1963 an average of 80 feet, or 10 feet per year. The southwestern tip of Ludlam Beach has undergone various periods of recession and advance to about 1920, with a net advancement averaging about 10 feet per year since 1847. There was no appreciable change between 1920 and 1963.

Seven Mile Beach—The entire inlet frontage of Avalon at the northeast end of Seven Mile Beach receded at a fairly continuous rate of about 8 or 9 feet per year between 1920 and 1963. Along the ocean coast the shoreline experienced continual erosion between 1955 and 1963, except for a 4,600-foot reach of shore near the north end and a 4,400-foot reach near the south end. At the north end, a maximum advance of 415 feet, or 52 feet per year occurred, while at the south end, an average advance of 100 feet, or 12.5 feet per year occurred. Along the approximately 23,300-foot reach of shore between these two areas, the shoreline receded an average of 51 feet, or about 6 feet per year between 1955 and 1963.

Five Mile Beach (The Wildwoods and Two Mile Beach)—Surveys dating to 1842 show that the shoreline in this reach has experienced periods of both recession and advancement before and after construction of the Cold Spring Inlet jetties in 1911. However, since the construction of these jetties, the shoreline to the north has predominantly advanced seaward while some recession occurred at North Wildwood between 1928 and 1955. Between 1928 and 1965, the entire ocean shoreline in this reach advanced seaward at a rate averaging approximately 13 feet per year. However, in the latter part of this period, the shoreline receded by as much as 8 feet per year.

Erratic and frequent change in the shoreline configuration along the inlet frontage of North Wildwood (at Hereford Inlet) and along more than one mile of ocean frontage adjacent to the inlet have occurred since 1842, due principally to the southwestwardly migrating inlet channel. Along the inlet frontage of North Wildwood the 1899 survey showed that the tip of the barrier had shifted southward (recession)

2,400 feet since 1842 (42 ft. per year). By 1920 the tip had further receded southward an additional 1,000 feet (48 ft. per year) and an island (Champagne Island) formed in Hereford Inlet 1,600 feet northeast of the tip. This island was 3,800 feet long and 1,400 feet wide. By 1928 it had become a spit attached to the northeastern corner of North Wildwood. By 1963 the spit had been completely eroded by the southwestwardly migrating inlet channel. The inlet frontage shoreline remained relatively unchanged between 1963 and 1965. While these changes were occurring along the inlet frontage, substantial changes were also taking place along the adjoining one-mile reach of ocean frontage of North Wildwood. Movements of the ocean frontage shoreline at this locality were as follows: 1842 to 1880, a recession of 1,200 feet (32 ft. per year); 1880 to 1899, a seaward advancement of 1,000 feet (53 ft. per year); 1928 to 1955, a seaward advancement of 110 feet (40 ft. per year); 1955 to 1963, a seaward advancement of 900 feet (112 ft. per year) and between 1963 to 1965, a recession of 175 feet (88 feet per year).

Cold Spring Inlet to Cape May Point—Surveys dating to 1842 indicate that the reach of shore between Cold Spring Inlet and the Alexander Avenue groin at the west corporate limit of Cape May Point experienced periods of both shoreline recession and seaward advancement, with recession predominating. The net change between 1928 and 1965 was a recession of the mean high water shoreline averaging about 9 feet per year, or about 333 feet during the 37-year period. Since 1928, the shoreline recession has been greatest at the U.S. Coast Guard Base immediately south of Cold Spring Inlet and Lower Township and Cape May Point. The shoreline at Cape May has essentially been stabilized by a stone seawall and a system of groins. However, the relatively narrow beach fronting the wall has experienced a net recession since 1928. The shoreline recessions are due largely to the impoundment of littoral drift upcoast of the Cold Spring Inlet jetties (completed in 1911), with the resultant starvation of the beaches downcoast. Erosion has generally been severe at Cape May Point, particularly prior to the initiation of groin and bulkhead construction in the 1930's. Although many of these structures have since been destroyed, they had been effective in retarding the rate of recession. The existing groins have similarly retarded the rate of loss.

Critical Erosion Areas. The shore areas experiencing serious erosion problems have been investigated in a study of the New Jersey Coastal Inlets and Beaches discussed in Section E of this report. Of the total shore frontage of 97 miles between Manasquan Inlet and Cape May Point, the length of critical erosion totals about 74 miles. About 12 other miles have a history of erosion, but the problem is not considered critical. The remaining frontage of about 11 miles has a history of stability or accretion. Locations of critical erosion are shown on Plates 35, 37, 39, and 41.

11. BARNEGAT BAY TO CAPE MAY HARBOR, NEW JERSEY

General. In general, shoreline erosion is due principally to the action of storm or wind-generated waves and currents. Some areas adjacent to inlets, such as at Little Egg, Beach Haven and Great Egg Harbor Inlets experience the continual effects of scouring tidal currents and the normal littoral processes common to the ocean shores.

Available data on the extent of erosion is minimal. Erosion is generally most severe in the vicinity of inlets.

The only readily available information on historical changes of the bay shorelines are old Coast and Geodetic Survey charts. A study of these charts dating to 1935 does not reveal any significant changes in shoreline configuration, except at inlet locations and in areas where development has taken place.

Critical Erosion Areas. Of the total 240-mile length of bay shoreline, 10 miles are considered

to be in a critical erosion condition. Erosion has occurred along 63 miles of the shore, but is not considered critical. The remaining 167 miles of shore, while experiencing some local erosion, are considered to be essentially stable. Plates 35, 37, 39, and 41 show areas of critical erosion.

12. SANDY HOOK TO MANASQUAN INLET, NEW JERSEY

General. The shoreline of this reach for the period between 1835 and 1932 was generally subject to erosion. The shoreline from the tip of Sandy Hook Peninsula to Sea Bright, experienced intermittent stretches of erosion and accretion, the maximum landward movement being 700 feet and the maximum seaward movement being about 1,000 feet. Erosion occurred throughout the remainder of the reach with a maximum landward movement of 600 and 500 feet at Elberon and Bradley Beach, respectively. From 1932 to the summer of 1953, accretion and seaward movement of the shoreline predominated along this reach. Erosion occurred along the Sandy Hook Peninsula during this period, the maximum landward movement amounting to about 700 feet. The shoreline at Long Branch remained relatively stable during this period, while the remainder of the reach from Sandy Hook to Manasquan experienced seaward movement. The most significant seaward movements of up to 1,000 feet occurred at Shark River and Manasquan Inlets, where jetties were constructed.

During the period of record, offshore depth contours in this reach generally advanced (seaward movement), with the exception along the southern section of Sandy Hook Peninsula and south to Sea Girt, where the offshore depth contours retreated (landward movement) during this period. However, during the period 1932 to 1953, offshore depth contours along this reach retreated up to about 300 feet.

Critical Erosion Areas. Erosion presents a serious problem along practically the entire coast between Sandy Hook and Manasquan Inlet as shown on plate 43.

13. RARITAN BAY AND SANDY HOOK BAY, NEW JERSEY

General. Generally, the shoreline of this reach for the earliest period between 1836 and 1855-56 had the greatest recession, with a maximum of 8 feet per year occurring in a portion of the reach.

During the period of record, offshore depth contours in this reach have exhibited erratic movement without any apparent pattern except that the 6-foot countour has remained practically parallel to the shore along most of this reach. Since 1836 there has been offshore and onshore movement of the depth contours, generally over a zone of several hundred feet, but without any consistency.

Critical Erosion Areas. The shore areas where erosion presents a serious problem are the areas in Monmouth County shown on plate 43.

14. FORT WADSWORTH TO ARTHUR KILL, STATEN ISLAND, NEW YORK

General. The shoreline of this reach for the period between 1836 and 1961 generally experienced a recession, except for the portion of Fort Wadsworth to New Creek Where an average annual rate of accretion of 0.4 foot occurred. However, during the period 1836-1855, a maximum recession of 9.1 feet per year occurred for a portion of this reach. Shoreline accretion for the period 1933-35 to 1961 has been predominant along this reach largely as a result of artificial fill placed along the shore.

During the period of record, the offshore depth contours have exhibited erratic movements without any apparent pattern. In general there has been an onshore movement of the

contours, but with substantial offshore movements in many areas.

Critical Erosion Areas. The shore areas where erosion presents a serious problem include portions of the shore between Graham Beach and Great Kills Park, between Arbutus Lake and Seguine Point at Tottenville Beach. Erosion problems exist along most of the shore areas which are fronted by bluffs. Critical erosion areas are shown on plate 45.

15. ROCKAWAY INLET TO NORTON POINT, NEW YORK

General. Examination of the shoreline changes of Coney Island reveal that although it has experienced periods of both recession and advancement, the shoreline has moved seaward since the first reliable survey was made of the area in 1835. The shoreline changes also reveal a continual migration of Norton Point to the west.

From 1835 to 1855-56 the shoreline advanced along the western one-third of Coney Island, and retreated along the eastern two-thirds due primarily to the formation of a 12,000-foot long and 500-foot wide bar, 1,500 feet offshore. Material forming this bar apparently came from the shore or nearshore area Between 1855-56 and 1876 this bar disappeared resulting in a general advancement of the entire Coney Island shore.

Between 1876 and 1885 the shoreline receded along the eastern one-half of Coney Island and advanced along the western one-half. Between 1885 and 1908 the shoreline along the eastern 1/2 retreated but from 1908 to 1934 was offset by an equal advancement. Between 1934 and 1966 the shoreline remained relatively stable except for minor advances along the middle one-third, where fill was placed in 1941 and 1961 by the City of New York.

Norton Point moved westward more than 700 feet between 1835 and 1966. Its greatest migration occurred between 1855-56 and 1876 when it advanced over 550 feet to the west or over 26 feet per year. Since 1885 there has been no appreciable westward movement of Norton Point.

Critical Erosion Areas. Although the beach along this shore has been generally stable in recent years, primarily due to artificial nourishment and groin construction, an erosion problem has resulted from storms of unusually severe intensity which have struck the area. Erosion has produced a reduction in the width of portions of the beach causing a loss of the beach area available for recreation use. The bulkheads, seawalls and groins which have been constructed in the study area have provided a measure of protection. Further improvement and stabilization of the shore are needed to protect existing development against damage from erosion and wave attack and to provide larger areas for recreation. Critical erosion areas are shown on plate 45.

16. EAST ROCKWAY INLET TO ROCKAWAY INLET, NEW YORK

General. The shoreline of this reach for the period 1835 to 1878 generally receded. Simultaneously, Rockaway Point extended about two miles westward, while the area which is now Jacob Riis Park acquired approximately its present shoreline. However, between 1878 and 1927 the shoreline generally advanced a small amount except at Edgemere, where there were alternate periods of erosion and accretion. The shoreline for the period 1927 and 1961 has generally been stable or accreted slightly.

During the period of record, offshore depth contours in the area were generally stable except near Rockaway Point where they receded by large amounts as the shoal south of Riis Park eroded and moved westward, with a large accumulation of sand in a new shoal to the southeast of the jetty at Rockaway Point.

Critical Erosion Areas. Since the area is vulnerable to severe erosion and damage during storms, the entire reach is considered critical and is shown on plate 45.

17. SOUTH SHORE OF LONG ISLAND, NASSAU AND SUFFOLK COUNTIES, NEW YORK

General. The shoreline in recent years indicates some erosion east of East Hampton, a shore eroding from 6.0 to 10.0 feet per year from East Hampton to Fire Island Inlet and about 3.5 feet per year from Fire Island Inlet to Jones Inlet. The shore from Jones Inlet to East Rockaway Inlet indicates accretion adjacent to the inlets and erosion in-between up to 7.0 feet per year.

During the early period of record, 1839 to 1896 there were generally localized seaward movements of the offshore contours in the Montauk Point area. However, along the barrier beach section there was a landward movement of the contours from 1933 to 1940 and seaward from 1940 to 1956. In the portion of this reach between Fire Island and Jones Inlets for the period, 1834, there was little movement of the offshore depth contours except near the inlets. At the tip of Jones Beach seaward movement of up to 2,300 feet and landward movement of 2,500 occurred. In the western portion of this reach the offshore depth contours have generally remained stable, except for accretion immediately east of the East Rockaway jetty and in the Point lookout and eastern Lido Beach areas and erosion along the western Atlantic Beach area.

Critical Erosion Areas. Since the area is vulnerable to severe erosion and damage during storms, the entire reach is considered critical and is shown on plates 45, 47, and 49.

18. SHORE OF GREAT SOUTH BAY AND ADJOINING LESSER BAYS, LONG ISLAND, NEW YORK

General. Available data on extent of erosion is minimal. Local erosion problems have been reported in Babylone, Sayville and Islip.

Critical Erosion Areas. No critical erosion areas have been found within this reach.

19. EASTERN FORKS OF LONG ISLAND, SUFFOLK COUNTY, NEW YORK

General. Available data on the extent of erosion is minimal. From observations and field inspections made in this reach it is known that bluff areas are eroding and beaches along spits and necks undergo yearly changes from erosion.

Critical Erosion Areas. Shore areas critically affected by erosion are to be found along the bluff shores in Amagansett, Great Hog Neck, and Gardiners Island. Beaches at Little Hog Neck and in Amagansett are also critically affected. Erosion of the shore at Orient Point has allowed this area to be subject to frequent tidal inundation. Serious erosion problems exist along many of the shore areas which are fronted by bluffs. Critical erosion areas are shown on plate 49.

20. NORTH SHORE OF LONG ISLAND, SUFFOLK COUNTY, NEW YORK

General. The shoreline of the reach for the period between 1836 and 1965 has receded at an average rate of between 1.0 to 2.0 feet per year. Some locations such as at Eatons Neck, Waterside Park, Fort Salonga, Crane Neck, Old Field Point, Mt. Misery, and Mattituck Hills have experienced severe recessions of up to 3.5 feet per year. The shoreline from Miller Place to Mattituck Inlet, fronted primarily by high bluffs lying in long and gently curved reaches, has generally experienced a recession of about 2.0 feet per year. Shoreline accretion has occurred primarily at locations where wave-built forms such as sand spits and barrier bars exist. At some of these locations such as Lloyd

Neck, East Fort and Eatons Neck Point, Sunken Meadow State Park, Port Jefferson Harbor, and at Mt. Sinai Harbor, the bars or spits have experienced migrations of considerable magnitude.

During the period of record, offshore depth contours in the study area generally retreated (landward movement). In the vicinity of offshore shoals at projecting headlands, along barrier bars, and offshore of entrances to harbors and estuaries, there were advances (seaward movement) of up to 3,500 feet during short periods. Some locations where significant movements of the offshore depth contours occurred are: Lloyd Point, Eatons Neck Point; Asharoken Beach; Crab Meadow; Crane Neck Point, Mt. Misery; Rocky Point Landing; Herod Point; Roanoke Point and Goldsmith Inlet.

Critical Erosion Areas. The entire shore frontage of about 87 miles is considered critical. Noteworthy problem areas include Sunken Meadow, Caumsett and Wildwood State Parks; Valley Grove area, west shore of Eatons Neck; U.S. Coast Guard Station, Eatons Neck Point; Waterside Park shore, Northport; Fort Salonga area of Northport; Fresh Pond; Nissequogue; West Meadow Beach; Crane Neck; Flax Pond; Village of Old Field, between Flax Pond and Old Field Point; Old Field Point; Mount Misery, Village of Belle Terre; Wading River Landing; Luce Landing; shore east of Goldsmith Inlet; Horton Neck Point; and Truman Beach. Erosion of bluffs is serious along many shore areas. Critical erosion areas are shown on plates 47 and 49.

21. NORTH SHORE OF LONG ISLAND, NASSAU COUNTY, NEW YORK

General. Except for the portion of shore between Barker Point and Mott Point in this reach, no studies have been made of shoreline and offshore depth changes. The shoreline of the portion of shore studied for the period 1836 - 1958 experienced an average recession of 0.7 to 1.7 feet per year which occurred for an area between Prospect and Mott Points. However, accretion occurred west of Mott Point where the shoreline moved seaward an average of 0.5 foot per year. From 1886 to 1958 the fluctuation of the shoreline has been of much lesser magnitude from Prospect to Mott Points with a relative balance between accretion and erosion. In front of the former Navy property there was a net recession for this period averaging about 54 feet. The average recession from 1836 to 1886 in front of the former Navy property was about 160 feet.

During the period of record, offshore depth contours for a portion of the reach exhibited an erratic movement without any apparent pattern. Since 1836 there was offshore and onshore movement of the depth contours, the 6-foot contour ranging over a zone of 400 feet (maximum) and the 18-foot contour over 500 feet (maximum), but without any consistency.

Critical Erosion Areas. Shore areas critically affected by erosion are to be found along the high bluffs in Manhasset, Port Washington, Sands Point, Sea Cliff and Glen Cove. Low beaches in Glen Cove and along Center Island are also critically affected. Critical erosion areas are shown on plate 45.

22. SHORE OF NEW YORK CITY ALONG LONG ISLAND SOUND - WESTCHESTER COUNTY TO THROGS NECK

General. Some areas along Rodman Neck for the period 1837 to 1883 experienced erosion and accretion with erosion slightly predominating. For the period 1837 to 1953 the shoreline along the northern third of Rodman Neck experienced a net recession ranging from 0 to 70 feet. However, accretion ranging from 9 to 100 feet occurred along the middle third and about equal widths of erosion and accretion occurred along the southern third. Erosion has generally occurred along the northern portion of the shore of City Island. For the period 1837 to 1883 the entire length from 100 to 250 feet experienced a recession aver-

aging about 150 feet. However, between 1883 and 1933 accretion and erosion, with erosion dominating, occurred along the same lengths resulting in an average recession of about 100 feet. Along the shore of Hart Island both erosion and accretion occurred. Between the period 1837 to 1933 accrettion occurred along the southern end of the island for about 800 feet, thence erosion occurred along the remainder of the shore except along 600 feet just north of the easterly point. Generally accretion has advanced the low-water shoreline along the entire face of Hart Island. For the period 1883 and 1933 the shore for the entire length of the island advanced from 0 to 250 feet.

During the period of record, 1883 to 1933 the offshore depth changes in the Rodman Neck portion of this reach there was a shoreward movement of the offshore depth contours. In the City Island portion of this reach the offshore depth contours experienced great changes along the east side of the island. The 12-foot curve moved shoreward as much as 1,500 feet in places, but the extent of the change was not uniform along the shore. However, for the entire period of record the offshore depth contours had a net movement shoreward. Along Hart Island the 6-foot contour moved shoreward. The 12-foot contour indicated shoaling along the northeast face of the island and a recession, then shoaling along the southern portion of the island. The changes in the 18-foot contours along the northern part of City Island and the northern part of Hart Island are irregular with alternate short areas of advances and recessions with a net resulting change of a slight shoaling along these shores.

Critical Erosion Areas. There are no known critical erosion areas in this reach. Erosion problems have been reported on the eastern shore of City Island.

23. WESTCHESTER COUNTY, NEW YORK, ALONG LONG ISLAND SOUND

General. Available data on the extent of erosion is minimal. Erosion problems have been reported at Glen Island and Rye Town Park.

Critical Erosion Areas. There are no known critical erosion areas in this reach.

24. CONNECTICUT (FAIRFIELD, NEW HAVEN, NEW LONDON & MIDDLESEX COUNTIES)

General. The Connecticut shorefront and Fisher's Island are generally subjected to erosion processes produced by storm-driven waves occurring during storms and to the less frequent hurricanes. Occasionally, an easterly storm of long duration builds up a surge within Long Island Sound causing erosion in isolated areas. This is usually within the Bridgeport-Stamford area where a higher normal tidal range occurs than along the eastern sectors of the Sound. The area from the New York line to Norwalk Harbor is generally less susceptible to erosion than the remainder of the coast because of its rocky structure.

Critical Erosion Areas. Critical erosion along the Connecticut coast and Fisher's Island is usually a loss of beachfill from improved and unimproved beach areas, unprotected backshore consisting of erodible unconsolidated materials, or sandy bluffs or dunes, the latter being particularly predominant along the Fisher's Island shorefront. Undermining of some manmade structures (stone revetment, timber or steel bulkheads or concrete seawalls) is a common occurrence requiring costly maintenance. It is estimated that the rate of recession of sectors of some exposed beaches and unprotected backshore areas probably averages about 1 foot a year. The sand moves offshore to form bars and spits with little or no natural return to the beach between storms due to the lack of beach building swells as is common along the Atlantic Ocean exposure. Consequently, beach areas are continually lowered and diminished in width as protective beach berm features. The only means of

restoration is by artificial sand replenishment measures. Critical and noncritical erosion areas are located on Plate No. 53. Of the 270 miles of shorefront including Fisher's Island, 25 miles are in a state of critical erosion. Of this amount it is estimated that about 20 miles consists of inadequate beaches.

25. RHODE ISLAND, INCLUDING BLOCK ISLAND (COUNTIES OF KINGSTON, WASHINGTON, KENT AND NEWPORT)

General. The beach erosion studies for the south shore of Rhode Island and a study completed for Cliff Walk indicate there has been no apparent major shoreline recession. In a large part this has been due to the rocky nature of portions of the shore and artificial structures that retard erosion. About 30 percent of the shore is estimated to consist of rock. Most of the south shore west of Narragansett Bay consists of sandy beaches and dunes. Historical topographic and hydrographic surveys have been limited. Any major backshore recession has been attributed to hurricanes causing tidal surges much higher than do ordinary storms, thus allowing larger waves to overtop beaches, dunes and backshore structures. In a few areas there has been critical erosion while accretion has occurred in a few places usually located at major inlets controlled by extensive jetty construction. There is no study information available for the Narragansett Bay area or Block Island. However, erosion within Narragansett Bay is generally negligible, controlled in most areas by private or municipal improvements. Block Island has very serious losses along its shores because of its geological structure of erodible glacial materials and its exposure to large storm-driven waves.

Critical Erosion Areas. The most critical erosion areas are located along sectors of erodible beaches located west of Narragansett Bay, the upper slopes along Cliff Walk and along most of the shorefront of Block Island. It is estimated that 25 miles of shorefront of which about 80 percent are beaches of inadequate width, experience critical erosion while the remaining miles are non-critical. For location of these areas see Plate 55.

26. MASSACHUSETTS ELIZABETH ISLANDS, MARTHA'S VINEYARD, NANTUCKET (DUKES COUNTY)

General. Very little is known about the shore history of the Elizabeth Islands, however, they are less exposed to ocean-driven waves than sectors of the shores of Martha's Vineyard and Nantucket Island. Southeasterly storms and easterly storms likely cause the greatest loss of material along the southwestern, southerly and eastern exposure.

Martha's Vineyard experiences rapid losses along sectors of its easterly exposure and south shore during frequent easterly storms and southerly storms, respectively. The easterly and southerly exposure of Nantucket Island is similarly affected. The northerly shorefront of both these islands fronting Nantucket Sound experiences less serious problems due to the more sheltered exposure of their northerly coastal area to the more frequent easterly and southerly storm-driven waves.

Critical Erosion Areas. Because of the absence of available study information for the Elizabeth Island area the magnitude of critical erosion is not known. It is believed from a practical standpoint that critical erosion would be confined to the southwest exposure of Cuttyhunk Island and the easterly portion of the chain.

Field investigations and limited study of Martha's Vineyard indicate that the critical erosion as discussed would be confined to sectors of the island at the easterly exposure, the entire south shore, and the westerly sector at Gay Head Cliffs. The losses along the south shore probably average in excess of 3 feet a year with shoreline erosion at the base of the Gay Head Cliffs, probably averaging at least 1

foot a year. Nantucket Island, as discussed, experiences its greatest erosion along sectors of the eastern and southern exposure. It has been reported that some of these areas average as much as 8 feet a year with certain sectors having lost in excess of 15 feet in any one year. (See Plate No. 57 showing the shore characteristics and erosion.) Of the 300 miles of shorefront contained in this reach, 60 miles are considered critical, mainly inadequate fronting beaches, 230 miles non-critical, with the remainder accreting.

27. RHODE ISLAND STATE LINE TO PROVINCETOWN. BRISTOL, PLYMOUTH AND BARNSTABLE COUNTIES

General. This reach of shorefront has not been studied as intensively in the interest of beach erosion control as has the coast north of Provincetown. Consequently, factual information for most of this shoreline is not available. Therefore, it is based on information obtained from beach erosion surveys completed by the Corps for portions of this area, engineering judgment and information obtained from local interests and published material pertaining to the coastal geology. The south shore has some areas where moderate offshore losses are experienced. However, a substantial amount of material transported alongshore by the littoral current helps to balance offshore losses. Much of the backshore that is heavily developed and lacks natural protection contains protective improvements that limit or prevent landward recession. The area experiencing the most severe erosion problems is along much of the eastern exposure of the outer arm of the Cape. This section is directly exposed to frequent storm-driven waves approaching over an unlimited fetch from the northeast. As for the south shore, littoral transport helps to balance the large offshore losses.

Critical Erosion Areas. The high steep bluffs extending nearly continuously north of the northern extremity of Nauset Beach experience the most critical overall erosion within the study area. The easterly exposed beach berms of Nauset Beach and Monomoy Island have experienced large and variable changes. It is estimated that losses along much of this outer shorefront average in excess of 3 feet per year. Although during some years certain sections have experienced in excess of 8 feet a year. The critical erosion areas along the south shore of the Cape are generally confined to certain sectors of private or public recreational beach areas, with a reduction of beach berm area below desirable recreational use and protective limits. Of the 440 miles of this reach of shorefront, it is estimated that 40 miles experience critical erosion. (See Plate Nos. 59 and 61 for location of critical erosion areas.) It is estimated that in excess of 35 miles of the critical erosion is in areas with an inadequate protective beach.

28. PROVINCETOWN TO PEMBERTON POINT, MASSACHUSETTS BARNSTABLE AND PLYMOUTH COUNTIES

General. The analysis of erosion experienced within this reach of shorefront is based on limited study data and practical judgment as evaluated through numerous individual problems as investigated with local interests from time to time. The areas as described have a high percentage of erodible backshore consisting of high bluffs, or dunes fronted by beaches; these beaches often having limited protective beach berms. The areas most susceptible to erosion are of this type of physical structure and geologically made up of glacial deposition of unconsolidated materials with the erosion limited by the type of exposure to storm-driven waves. The area extending from Provincetown to the Cape Cod Canal although being sensitive to erosion due to its geological structure does not experience general erosion

along the westerly and southerly exposure of the outer arm fronting Cape Cod Bay. The more severe erosion areas from Provincetown to the Cape Cod Canal are at the outer extremity of the arm and along sectors of the easterly shorefront extending from the vicinity of the Cape Cod Canal north where frequent northeasterly storms cause some erosion of the toe of bluffs or dunes and fronting beach areas. There are no accurate figures on the magnitude of erosion.

Critical Erosion Areas. The stretches of shorefront experiencing the most severe erosion are located within the sector extending north of Cape Cod Canal. One such area extends from the Canal to Manomet Point where moderate erosion is experienced to the toe of the bluffs and the fronting beach berms. To the north, sections of Duxbury and Plymouth beaches have a history of erosion. Probably the most serious erosion is experienced at the higher bluff areas designated as First, Second, Third and Fourth Cliffs located in the towns of Marshfield and Scituate. One other bluff area with serious erosion is located at the northerly limit of the study area at Point Allerton. Sectors of these bluffs experience serious wave undercutting, combined with rapid downslope fresh water runoff occurring during frequent serious storms. The erosion threatens scattered residential properties and at Fourth Cliff the unprotected U.S. Air Force Property. The erosion of some beach areas has exposed structures along the backshore to frequent damaging wave forces. Of the 200 miles of shorefront contained in this reach, it is estimated that 20 miles of shorefront of which three-quarters is inadequate beach areas experience critical erosion for areas as described and shown on Plate Nos. 61, 63, and 65.

29. BOSTON COMPLEX — PEMBERTON POINT THROUGH BEVERLY, MASSACHUSETTS (NORFOLK, SUFFOLK, MIDDLESEX AND ESSEX COUNTIES)

General. Much of the inner harbor complex within this reach is protected from the larger storm-driven waves by the numerous offshore islands, tombolos and other projecting land features. Much of the backshore area is protected from further landward recession by the nearly continuous alongshore protection work.

Critical Erosion Areas. Of 150 miles of shorefront in this reach it is estimated 10 miles experience critical erosion. The erosion along the mainland shorefront generally consists of lowering and narrowing of some fronting beaches with damage experienced at backshore structures. The outer islands, because of their exposure and geological structure of erodible glacial deposits, experience serious erosion along their exposed faces. For location and extent of the critical erosion areas of which about 8 miles is inadequate beach, see Plate No. 65.

30. BEVERLY, MASSACHUSETTS TO NEW HAMPSHIRE LINE (MIDDLESEX AND ESSEX COUNTIES)

General. Erosion along this reach of shorefront is generally experienced during frequent northeast storms when higher tide levels allow the storm-driven waves to overtop beaches resulting in substantial loss of protective and recreational beach areas, undercutting of dunes and embankments and damage to backshore structures and property. Most of the area subject to damage is located within the northern one-half of the reach where the more extensive sandy beach areas are located. There are a few areas along the southern half of the reach where damage to exposed protective improvements and erosion of a few scattered embankment areas occur. The rocky nature of the southern half of the reach has made the problem of erosion here far less serious than along the northern half. The construction of man-made structures along the shorefront has helped to retard the erosion processes. The large jetty structures constructed at the mouth of the Merrimack River by the Federal government have served to stabilize the mouth of the river

and resulted in accretion immediately adjacent to the structure.

Critical Erosion Area. It is estimated that about 5 miles of shorefront of which about ninety percent is inadequate beaches, experienced critical erosion within the reach. These areas, as shown on Plate 65 are located along the south shore of the Merrimack River near its mouth, a sector of the ocean shorefront at the northern extremity at Plum Island and a substantial portion of Crane's Beach. The northern sector of Plum Island has experienced serious erosion through the years with the loss of several hundred feet of fronting beach and with several cottages seriously damaged or swept into the sea. Many cottages have been moved inland now fronting an alongshore road thus being moved inland to the maximum possible. The south shore of the Merrimack River has recently experienced severe erosion with a serious loss of the Coast Guard land including undermining and loss of one building exposing the remaining property to future serious losses. At Crane's Beach the deterioration of large shorefront dunes that formerly fronted the public parking lot and other facilities has exposed the recreational development to serious storm damages.

31. NEW HAMPSHIRE

General. In general, changes occurring along the New Hampshire coast are not large or rapid. This is due in part because of the rocky nature of much of the New Hampshire shorefront. The difficulties associated with accurate mapping of the steep and irregular shoreline has made it impossible to accurately map much of the rocky areas. The more reliable analysis of shoreline changes has been at beach areas where comparative profiles have been made. The north end of Seabrook Beach and the south end of Hampton Beach were formerly subject to large rapid changes, alternatively accretion and erosion associated with northward and southward migration of Hampton Harbor inlet. These large movements ceased with stabilization of the inlet by jetty construction during 1934-1935. Since stabilization of the inlet, Seabrook Beach has alternated between erosion and accretion, the net effect of these changes resulting generally in only small shoreline movements. Changes along Hampton Beach since the inlet stabilization consist principally of accretion at the north jetty structure as a result of sandfill placed behind the north jetty during 1934-35 and along the Hampton Beach shorefront about 1.5 miles to the north in 1955 and 1965. There has been some minor recession at the northern end of Hampton Beach. The construction of the groin structure at the northern sector of Hampton Beach in 1965 has retarded the southerly movement of material from the northerly 1,000 feet of beach that had occurred prior to the construction.

Critical Erosion Areas. The construction of man-made protective structures along exposed areas of the coast fronting erodible property has prevented or minimized backshore erosion. The erosion then is primarily a net gradual lowering of the sandy beach areas resulting in a narrowing of dry beach widths and exposing a few protective structures to wave action and low coastal roads to some overtopping during frequent storms. The erosion would be classified as generally minor within expected amounts probably not exceeding 1 foot a year at sections of such beaches as Hampton, Seabrook and Wallis Sands, with some sand nourishing sections of the beach or shorefront to the south. There is a need for additional beach widening, however, to provide much needed recreational use beaches at such areas as Hampton North and Foss Beach; such areas classified as critical erosion. Of the 40 miles of shorefront 2 miles of inadequate beaches are considered as critical as shown on Plate No. 67.

32. NEW HAMPSHIRE STATE LINE TO KENNEBEC RIVER, MAINE (YORK, CUMBERLAND AND SAGDAHOC COUNTIES)

General. There have been very few coastal

erosion studies completed along the Maine coast upon which to present a detailed historical account applicable to the entire reach of shorefront. Information, then, is largely based on field investigations, reports of local interests and preliminary analysis of surveys made for a few beaches where beach erosion control studies are in progress. Much of the shorefront, south of Portland, contains areas of ledge outcrops even though this sector contains most of Maine's recreational beach areas. The rocky areas would have little or no shoreline changes through the years. The most marked changes are then associated with areas sensitive to movement by wave action such as the extensive sandy beach and dune areas and in a few instances gravelly embankments or artificial fills, the latter being mainly coastal roads. With the small amount of available material through natural littoral transport, these beach areas will continue to deteriorate. In some areas, however, there are conditions of large accretion favoring beach widening. However, these are mainly limited to locations where seaward extending structures have caused an accreting condition, such as at Wells Harbor where accretion at the jetties has caused substantial widening of the beach, particularly south of the inlet.

Critical Erosion Areas. It is estimated that within this reach there are about 20 miles of shorefront experiencing critical erosion as shown on Plate No. 69. The erosion is mainly confined to recreational beach areas (in excess of 90 percent of the sector) where serious offshore losses experienced during frequent storms have lowered and reduced the beach width to below protective and recreational use requirements. There are some areas where protective backshore structures have had a history of serious damages. Such areas as the York and Kennebunk Beaches shorefront, Old Orchard Beach, Hills Beach and Perry Beach are among those reported as the more serious problem areas south of Portland, while the Popham Beach area at the northern extremity of the reach has a serious history of beach losses. Some of these areas have experienced losses of or serious damages to shorefront cottages.

33. KENNEBEC RIVER, MAINE TO CANADA

General. The history of this shorefront is not dramatically portrayed by observed changes of erosion and accretion due to its geological structure of massive ledge and rocky shorefront rather than the more sandy areas found along much of the shorefront south of Portland.

Critical Erosion Areas. There are no areas of critical erosion found within this reach of shorefront, although a very few small beach areas could be considered inadequate for desired use from the long-range standpoint. Most erosion of the non-critical type is in a few locations where coastal roads experience some damage, artificially filled areas at private or public dock areas and rare instances at some lower inner embayment areas where the geological structure becomes till or unconsolidated erodible materials.

D.

AUTHORIZED FEDERAL PROJECTS

D. AUTHORIZED FEDERAL PROJECTS

Federal Coastal Protection projects and navigation inlet projects are described in this section of the report and their locations are shown on plate 2. Information on those projects which have authorized beach erosion control features is summarized in Table 4 at the end of the report.

VIRGINIA

Description and Status. Two Federal beach erosion control projects have been authorized for the state and are described as follows:

a. Virginia Beach. One Federal Beach erosion control project has been authorized for the shoreline of Virginia Beach between Rudee Inlet and 49th Street, a distance of about 3-1/3 miles. The project, Virginia Beach, Virginia, Beach Erosion Control, provided Federal funds for beach restoration, construction of approximately 24 groins, and a 25-year program for periodic artificial placement of sand fill on the beach within the City between Rudee Inlet and 49th Street. The beach restoration work has been completed. The groins have not been constructed because experience to date indicates that periodic placement of sand by hydraulic pumping is the more suitable and economic method of maintaining stability of the shore. The 25-year program for artificial placement of sand on the beach is under way.

b. Colonial Beach. A Federal beach erosion control project has been authorized for the shoreline of Colonial Beach. This project is located on the southwest side of the Potomac River in Westmoreland County. As authorized, it would provide for construction of a stone revetment along State Highway No. T-1101 between Hawthorne Street and Castlewood Park. The project was authorized in 1950. No work has been done on this project.

MARYLAND

Description and Status. Two Federal beach erosion control projects have been authorized; one for beach erosion control and one for navigation as follows:

a. Oxford. The project, located in Talbot County on the south shore of the Tred Avon River, 2 miles above its mouth, provides for a 940-foot long sloped riprap stone revetment along the bank of a street in Oxford known as The Strand. The project is scheduled for construction in 1971.

b. Ocean City Harbor. This project provides an inlet channel between the Atlantic Ocean and Sinepuxent Bay, 10 feet deep and 200 feet wide, protected by jetties; a channel 6 feet deep and 150 feet wide from the inlet to Green Point and 100 feet wide into Chincoteague Bay; a channel 10 feet deep and 100 feet wide from the inlet to the west side of the bay with 2 turning basins; and for a channel 6 feet deep and 125 feet wide from the inlet channel to opposite North 8th Street, Ocean City, and 75 feet wide into Isle of Wight Bay. The above work was completed in 1936. Modification of this project was authorized by Congress in 1954 to provide a channel 16 feet deep and 300 feet wide from the ocean through the inlet to the Isle of Wight Bay channel, thence 200 feet wide and 16 feet deep to the project harbor, and a depth of 14 feet in the project harbor. No work has been done on this modification.

DELAWARE

Description and Status. Two Federal projects are described as follows:

a. Indian River Inlet and Bay. The Federal navigation project for Indian River Inlet and Bay provides for a channel 200 feet wide and 15 feet deep from that depth in the ocean through the inlet to a point 7,000 feet from the ocean shore line; thence nine feet deep and 100 feet wide in the bay and 80 feet wide in the river to Old Landing, and four feet deep and 60 feet wide from Old Landing to Millsboro; stabilization of the inlet by two parallel

jetties; and a turning basin at Old Landing. The project was completed in 1951. Major rehabilitation of the bulkheads was completed in 1964. Maintenance dredging in 1968 totalled 80,447 cubic yards.

b. Coast of Delaware. This project, which provides for the protection and improvement of the entire Atlantic Ocean shore at Delaware from Cape Henlopen to the Delaware-Maryland state line at Fenwick Island, modifies the prior authorized beach erosion control project covering the reach from Rehoboth Beach to Indian River Inlet.

The existing project, which was adopted in 1958 and modified in 1968, provides for widening of the beach by placement of suitable sand to provide a beach with a berm varying between 50 and 100 feet in width at an elevation of 12 feet above mean low water; construction of a dune with a top width of 25 feet at an elevation of 17 feet above mean low water; construction of timber bulkheads to elevation 16 feet above mean low water with stone toes and backfill, where dune construction is impractical; placing of stone revetment at the toe of about 1,200 feet of existing bulkheads; planting of dune grass and placing sand fences atop dunes; and periodic artificial placement of sand fill on the beach for the project life. The artificial placement of advance nourishment will be included in the initial construction of the project.

NEW JERSEY

Description and Status. Authorized Federal projects are described as follows:

a. Cape May City. The Federal beach erosion control project for Cape May City as adopted in 1954 and modified in 1960, and 1962, provides for widening the beach between Wilmington Avenue and a point 0.6 mile south of Windsor Avenue, a distance of about 12.4 miles, by artificial placement of suitable sand. It also provides for artificial placement of suitable sand on a feeder beach extending 0.6 mile eastward from Wilmington Avenue; construction of five new timber groins and extension of five existing stone groins (the groin construction was deferred pending demonstration of need); and periodic artificial placement of sand for nourishment on the restored beach for a period of 10 years from the year of substantial completion of the initial beach fill. Construction of two stone groins and the extension of three timber groins, which were part of the original project as adopted in 1954, have been completed.

b. Cold Spring Inlet. The Federal navigation project in this inlet provides a navigable connection between the Atlantic Ocean and Cape May Harbor and the New Jersey Intracoastal Waterway.

The project consists of an entrance channel 25 feet deep and 400 feet wide, protected by two parallel stone jetties, extending from the 25-foot depth curve in the ocean to a line 500 feet beyond the inner end of the jetties; and thence a channel 20 feet deep and 300 feet wide to deep water in Cape May Harbor. The project was adopted in 1907 and completed in 1942. (The 20-foot channel into the harbor was completed in 1942 with Navy Department Funds. This portion of the project was subsequently adopted by the Congress in 1945.) The jetties were rehabilitated in 1963-1966.

c. Five Mile Beach. The Federal beach erosion control project for Five Mile Beach was adopted in 1960 and modified in 1962; it provides for widening the ocean beach for about 0.5 miles between 16th and 26th Avenues (North Wildwood) by artificial placement of suitable sand to provide a beach with a berm 50 feet wide at an elevation of 10 feet above mean low water and periodic artificial placement of sand fill on the beach for a period of 10 years from the year of substantial completion of the initial beach fill. No work has been performed on this project.

d. Hereford Inlet. A project for emergency dredging of Hereford Inlet was approved 3 April 1967 under Section 3 of the 1945 River and Harbor Act. The project provides for a

navigation channel eight feet deep and 150 feet wide from the Atlantic Ocean to the New Jersey Intracoastal Waterway. The project was completed in 1967.

e. **Great Egg Harbor Inlet and Peck Beach.** The project provides for modification of the existing beach erosion control project at Ocean City, New Jersey, to provide for jetties; a deposition basin; a bulkhead, backfill, and revetment; an inlet chanlel 300 feet wide and 12 feet deep and an interiòr channel 100 feet wide and 6 feet deep to the New Jersey Intracoastal Waterway; placement of beachfill; inclusion of 9 existing groins; periodic nourishment of the beaches; and appurtenant works for jetty and bulkhead fishing.

f. **Corson Inlet and Ludlam Beach.** The project provides for jetties; a deposition basin; an inlet channel 300 feet wide and 12 feet deep and an interior channel 100 feet wide and 6 feet deep to the New Jersey Intracoastal Waterway; a bulkhead and backfill at Strathmere; placement of beachfill; removal or cutting off existing timber piling; periodic nourishment of the beaches; inclusion of two existing groins; construction of 10 additional groins as required; and appurtenant works for jetty and bulkhead fishing.

g. **Townsend Inlet and Seven Mile Beach.** The project provides for modification of the existing beach erosion control project at Stone Harbor, New Jersey, to provide for jetties; a deposition basin; an inlet channel 300 feet wide and 12 feet deep to the New Jersey Intracoastal Waterway; two groins and beachfill at Avalon; placement of beachfill; periodic nourishment of the beaches; inclusion of 6 existing groins; construction of 5 additional groins as needed; and appurtenant works for jetty fishing.

h. **Ventnor, Margate, Longport.** The Federal beach erosion control project for the contiguous communities of Ventnor, Margate and Longport, adopted 1960, and modified in 1962, provides for restoration and widening of over 1.0 miles of beach at Longport by artificial placement of suitable sand to provide a beach with a berm 50 feet wide at an elevation of about 10 feet above mean low water. Periodic artificial placement of suitable sand fill on the beach will require approximately 150,000 cubic yards every three years along the ocean front of Ventnor, Margate and Longport at such locations as may be indicated by experience. No work has been performed on this project.

i. **Atlantic City.** The project for protection and improvement of the shore lines of the City along Absecon Inlet and Atlantic Ocean was adopted by Congress in 1954 and modified in 1962 and 1965. The project was sesigned to alleviate beach erosion problem conditions along Maine Avenue (Absecon Inlet) frontages and along ocean frontages south of New Hampshire Avenue for a distance of 6,000 feet.

The project provides for: Replacement of damaged concrete seawall by a steel sheet-pile wall; construction of a stone jetty about 4,800 feet long extending from Brigantine Island parallel to and about 2,300 feet from Maine Avenue bulkhead; revetment of bulkhead along Maine Avenue; construction of one new groin and extension of existing groins along Maine Avenue; artificial placement of sand-fill to widen ocean and inlet beaches; extension of stone groins at Vermont Avenue; and periodic artificial placement of suitable sand fill of the restored beach for ten years after the first nourishment is placed.

The project is about 54% completed. The work remaining to be done consists of the completion of the stone jetty off Brigantine Island; placement of sand fill on the Maine Avenue beach frontage; completion of the revetment of Maine Avenue Bulkhead and continuation of periodic artificial placement of sand fill on the beach.

j. **Absecon Inlet.** The original project for improvement of this inlet was adopted in 1912 and completed in 1916. The existing project provides for an inlet entrance channel 20 feet

deep and 400 feet wide; a channel 15 feet deep and 200 feet wide, from the inlet entrance channel to Clam Creek; and a turning basin within the creek. This project was adopted in 1922, modified in 1946, and completed in 1957.

k. Long Beach Island. The existing beach erosion control project for Long Beach Island, adopted in 1960 and modified in 1962, provides for widening approximately 0.6 miles of beach at Ship Bottom, 1.3 miles at Brant Beach and 0.5 mile at Beach Haven and North Beach Haven by artificial placement of suitable sand to provide a berm width of 50 feet at an elevation of 10 feet above mean low water; constructing four timber groins and periodic artificial placement of suitable sand on the beach at appropriate locations. Only the initial beach fill at Ship Bottom and Brant Beach has been completed.

l. Barnegat Light. The existing project at the Borough of Barnegat Light, adopted in 1960, and modified in 1962 consists of constructing 180 feet of stone revetment and 90 feet of timber bulkhead, reconstructing and extending one stone groin and constructing two new timber groins, all of which are completed. Widening of 1,200 feet of beach by artificial placement of suitable sand and periodic artificial placement of sand fill on the beach, also a feature of the authorized project, has been deferred pending demonstration of need.

m. Barnegat Inlet. The project for improvement of this inlet consists of a channel protected by two converging stone jetties, 10 feet deep through the outer bar and 8 feet deep through the inlet. Provision is made also for a channel of suitable hydraulic characteristics extending in a northwesterly direction from the gorge in the inlet to Oyster Creek Channel, northwest of Sunset Shoal, and thence, by way of Oyster Creek Channel, to deep water in Barnegat Bay. The project was adopted in 1935, modified in 1937, and completed in 1940. Maintenance dredging of a channel to connect the main inlet channel with Barnegat City Harbor was authorized in 1946.

n. Manasquan River and Inlet. The Manasquan River was first improved by the United States between the years 1880 and 1909, under a project adopted in 1879, with subsequent modifications. The authorization provided for an outlet to the ocean six feet in depth, but the work was not successful. The existing Federal Project was authorized in 1930, and subsequently modified in 1935 and in 1945.

The project provides for a channel 14-feet deep and 250-feet wide, protected by jetties extending from the ocean to the inner end of the north jetty; thence 12 feet deep, and ranging from 100 to 300 feet wide, to within 300 feet of the New York and Long Branch Railroad bridge; a widening on the north side of the channel to a depth of eight feet, 200 feet wide, and for a distance of 3,150 feet; and a 27.5-acre anchorage 12 feet deep. The project length is 1.5 miles.

o. Atlantic Coast, Sandy Hook to Barnegat Inlet. The project for beach erosion control in this area was authorized in 1958 and provides for protection and restoration of several beach areas within three reaches of shore. Improvement consists of the placement of beach fill to obtain a berm width of 100 feet at elevation 10 feet above mean low water; and construction of new groins and extension of existing groins. The project provides for Federal participation in periodic artificial placement of sand fill on the beach for a period not to exeeed 10 years from the year of partial completion. Descriptions of the improvements authorized in each reach are given below.

(1) Seabright to Ocean Township: Place 11,020,000 cubic yards of beach fill; construct 23 new groins and extend 14 existing groins; and provide periodic artificial placement of 125,000 cubic yards of sand annually on feeder beaches.

(2) Asbury Park to Manasquan: Place 2,710,000 cubic yards of beach fill and provide

periodic artificial placement of 290,000 cubic yards of sand annually on feeder beaches.

(3) Point Pleasant Beach to Seaside Park: Place 2,340,000 cubic yards of beach fill and provide periodic artificial placement of 325,000 cubic yards of sand annually on a feeder beach. No work has been done on this project.

p. Shrewsbury River Inlet. The existing project for Shrewsbury River was modified in 1965 to include an inlet channel across the base of Sandy Hook Peninsula between Spermaceti Cove and Island Beach connecting the Atlantic Ocean with Shrewsbury River. The channel is to be 15 feet deep, 200 feet wide protected by parallel jetties spaced approximately 500 feet apart and through the land cut to be protected by bulkheads in extension of the jetties extending to the existing Shrewsbury River channel. The new inlet is to be spanned by a fixed highway bridge. Hydraulic model tests were started in March 1968 at the Waterways Experiment Station in Vicksburg, Mississippi to determine the effect the new channel would have on existing environmental conditions. Preconstruction planning is under way based on results of the model study. A sand by-passing system will be developed to stabilize the channel inlet and to place intercepted littoral material updrift of the jetties.

q. Sandy Hook Bay and Raritan Bay. The project for Sandy Hook and Raritan Bays, authorized in 1962 provides for beach erosion control and hurricane protection: Placement of about 0.6 mile protection improvements along four sections of shore as described below:

(1) Madison Township (shore and hurricane protection): Placement of about 1.7 miles of beach fill at elevations of 5.5, 10, and 15 feet above mean sea level; construction of about 0.4 mile of levees at an elevation of 15 feet above mean sea level; and construction of interior drainage structures.

(2) Matawan Township (shore protection): Placement of about 0.9 mile of beach fill at elevations of 5.5 and 10 feet above mean sea level.

(3) Borough of Union Beach (shore protection): Placement of beach fill at an elevation of 5.5 feet above mean sea level.

(4) Borough of Keansburg, East Keansburg, and West Keansburg (shore and hurricane protection): Placement of about 2.7 miles of beach fill at an elevation of 15 feet above mean sea level; construction of 2.3 miles of levees at an elevation of 15 feet above mean sea level, interior drainage structures, and three groins.

Design work is completed for Madison and Matawan Townships and Keansburg and East Keansburg area. Construction was initiated on the Madison Township portion in 1965 and was completed in 1967. A contract for the Keansburg and East Keansburg shore work phase of the project was awarded on 28 June 1968 and construction has been completed. The contract for the closure work phase of Keansburg and East Keansburg was awarded in May 1970, and construction has been initiated.

r. Perth Amboy. The City of Perth Amboy is located at the west end of Raritan Bay and the confluence of Raritan River and Arthur Kill. The project, authorized in 1965, provides for the construction of a 560-foot reach of bulkhead at the foot of Lewis Street, as a part of the master plan of the City of Perth Amboy. Construction of the first stage of the project was initiated by the State of New Jersey on 31 July 1968 and completed in November 1969.

NEW YORK

Description and Status. Authorized Federal projects are described as follows:

BEACH EROSION CONTROL, AND HURRICANE PROTECTION

a. Fort Wadsworth to Arthur Kill. The project is located on the easterly shore of Staten Island in New York City. Authorized by the Flood Control Act of 27 October 1965, the

project provides for combined shore and hurricane protection between Graham and Oakwood Beaches and at Tottenville Beach; shore protection at Great Kills Park and between Arbutus Lake and Saguine Point. The improvement includes 2.3 miles of beach fill and dunes at Tottenville Beach and between Graham and Oakwood Beaches; 2.1 miles of beach fill only at Great Kills Park and between Arbutus Lake and Seguine Point; 2.9 miles of levees at Tottenville Beach, Graham Beach and between Oakwood Beach and Great Kills Park; one groin each at Tottenville Beach and Seguine Point; interior drainage facilities including four pumping stations and a tide gate between Graham and Oakwood Beaches; and relocations. Also authority has been granted to include in a design memorandum an extension of the authorized project which would preclude the need of closure extending inland at Graham Beach and provide for an earth dike along the south edge of Seaside Boulevard with closure structures at existing points of access and for interior drainage facilities consisting of three pumping stations and small ponding. The project also provides for Federal participation in the cost of periodic artificial placement of sand fill on the beach for a period not to exceed 10 years after completion of the initial work in each section. The preliminary phase of preconstruction planning is nearing completion.

b. East Rockaway Inlet to Rockaway Inlet. The project is located along the south shore of Long Island in New York City, except for a small section at the easterly end which lies in Nassau County. Authorized under the River and Harbor Act of 27 October 1965, the beach erosion control and hurricane protection project provides for a hurricane barrier 4,530 feet long across the entrance to Jamaica Bay with a 300-foot navigation opening and tainter gates on each side of the opening; dikes and levees 1.2 miles long to high ground north from the barrier and dikes, levees, and floodwalls, 7.7 miles long, south and east from the barrier and along the ocean front to high ground at the eastern end of the Rockaway Peninsula; fill placement along the 6-mile oceanfront floodwall with a berm 100 to 200 feet wide at 10.0 feet above mean sea level; and stoplog structures, stairway ramps, road raising, and other appurtenant works, including fishing platforms on the hurricane barrier. It also provides for Federal participation in the cost of periodic artificial placement of sand fill on the beach for a period not to exceed 10 years after completion of the initial beach fill. Preconstruction planning for the project was initiated in 1967 and is about 40 percent complete. A hydraulic model study was conducted at the Waterways Experiment Station to determine the effects of the proposed project on the study area. The preliminary phase of preconstruction planning is under way.

c. Fire Island Inlet to Jones Inlet. The project is located on the south shore of Long Island in Nassau and Suffolk Counties. Authorized under the River and Harbor Act of 3 July 1958, the beach erosion control and navigation project provides for Federal participation in the restoration and protection of the shore from Fire Island Inlet to Jones Inlet by dredging the inlet shoal in Fire Island Inlet to relieve the pressure on tidal currents against Oak Beach; to provide a deposition area for littoral drift, and to obtain fill material for a feeder beach west of the inlet and Oak Beach. Work under the 1958 Act was accomplished in 1960 and 1964.

The project was modified by the River and Harbor Act of 1962, which provides for combined beach erosion control and navigation improvements comprising a littoral reservoir, a navigation channel, a deposition reservoir, dikes, jetty extension, and periodic transfer of littoral drift to a feeder beach. Preconstruction planning of the modified project including a model study, was initiated in 1965. The model study has been completed.

d. Fire Island Inlet to Montauk Point. The project is located on the south shore of Long

island in Suffolk County. Authorized under the River and Harbor Act of 14 July 1960, the beach erosion control and hurricane protection project provides for the widening of beaches along developed areas between Kismet and Mecox Bay to a minimum width of 100 feet at elevation 14 feet above mean sea level; raising dunes to an elevation of 20 feet above mean sea level from Fire Island Inlet to Hither Hills State Park, at Montauk and opposite Lake Montauk Harbor; planting grass on dunes; constructing interior drainage structures at Mecox Bay, Sagaponack Lake, and Georgica Pond; and construction not to exceed 50 groins, if needed. Work on the project is under way. The project also provides for sand by-passing included in Federal navigation projects at Moriches and Shinnecock Inlets. The project also provides for Federal participation in the cost of beach nourishment for a period not to exceed 10 years from the year of completion of a useful nourishment unit. Construction of two groins at East Hampton was completed September 1965, and planning for the construction of two additional groins in the area is now under way. Construction of 11 groins at Westhampton Beach in the Moriches to Shinnecock Inlet section was completed October 1966. Construction of another increment of work consisting of four additional groins and the placement of 6,000 feet of dune and beach fill along the shore at Westhampton, west of the eleven existing groin field was initiated in August 1969 and was completed on 12 November 1970. Planning and design has been initiated for a third increment of work at Westhampton Beach to consist of the construction of six groins, placement of beach and dune fill, planting of beach grass and the installation of sand fencing. The overall project is approximately 10 percent completed. Planning for construction of the improvement in the Fire Island Inlet to Moriches Inlet section which includes the Fire Island National Seashore was initiated in 1967, however, work was suspended to accomplish other increments of work of higher priority. Design of an additional increment of work to include groins, dune, and beach fill work has been initiated for the beach area immediately west of the present Westhampton construction work.

NAVIGATION

e. East Rockaway Inlet. The inlet is situated on the south shore of Long Island between the main body of the island and the western end of Long Beach. It is 10 miles east of Rockaway Inlet and about 27 miles by water south and east of the Battery, New York City. The existing project provides for a channel 12 feet deep at mean low water and 250 feet wide from the 12-foot contour in the Atlantic Ocean to the 12-foot contour in Long Beach Channel distance of about 0.6 miles protected by a jetty on the easterly side. This work is completed. The project for improvement also provides for construction of a jetty on the westerly side of the channel. The present improvement is considered adequate and construction of an additional jetty is not necessary.

f. Fire Island Inlet. Fire Island Inlet is situated on the south shore of Long Island about 50 miles by water south, and east of the Battery, New York City. It is the main entrance into Great South Bay from the Atlantic Ocean. The existing project provides for the construction of a jetty extending generally southwest and south for a length of 5,000 feet from high ground on Democrat Point at the west end of Fire Island, and a channel 10 feet deep and 250 feet wide from deep water in the ocean to deep water within the inlet. Work under this project was considered complete in 1953.

g. Sag Harbor. This harbor is located on the northern shore of the south fork of Long Island, about 24 miles west of Montauk Point. The existing project consists of a breakwater 3,180 feet long extending northerly from Conklin Point; an entrance channel 3,200 feet long, 100 feet wide, and 10 feet deep from Shelter Island Sound by way of the village

wharf to the mooring dolphins of the Standard Oil Company; a turning basin of the same depth; an anchorage area 8 feet deep between this channel and the breakwater; and a small anchorage area 6 feet deep between the village wharf and the Sag Harbor Yacht Club pier. The length of section included in the project is about 0.6 mile.

h. Jones Inlet. This small inlet is located on the south shore of Long Island connecting Hempstead Bay with the Atlantic Ocean. It is 37 miles southeast of the Battery, New York City. The existing project provides for an entrance jetty and a channel 12 feet deep and 250 feet wide, from that depth in the ocean through the inlet to the Loop Causeway Bridge over Long Creek. The length of section included in the project is about 2.1 miles. The project was completed in 1959.

i. Lake Montauk Harbor. This harbor is located on the east end of Long Island, about 3 miles by land west of Montauk Point and 125 miles by water east of New York City. It is land-locked on the east, south and west sides and is connected on the north with Block Island Sound by an artificial inlet. The existing project provides for a channel 12 feet deep and 150 feet wide extending from the 12-foot contour in Block Island Sound to the same depth in the existing yacht basin east of Star Island, for a boat basin 10 feet deep, 400 feet wide, and 900 feet long, located northwest of Star Island, repair and extension shoreward of the east and west jetties with sport fishing facilities on top of both jetties. The length of section included in the project is 0.7 mile. The project was completed in November, 1968.

j. Mattituck Harbor. Mattituck Harbor, a tidal inlet on the north shore of Long Island, is located 85 miles east of the Battery, New York City, and 24 miles southeast of New Haven Harbor, Connecticut. The existing project provides for a channel 9 to 7 feet deep at mean low water from Long Island Sound to a 460 by 570 foot anchorage with an 8-foot depth, at the village of Mattituck, protected at the entrance by two parallel jetties. The total length of the channel is about 2.2 miles. The project was completed in 1965.

k. Moriches Inlet. This inlet is situated on the south shore of Long Island about 80 miles east of the Battery, New York City, and connects the Atlantic Ocean with Moriches Bay. The existing project authorized in 1960 provides for an entrance channel 10 feet deep and 200 feet wide from the Atlantic Ocean to Moriches Inlet, thence an inner channel 6 feet deep and 100 feet wide to the Long Island Intracoastal Waterway, a total distance of 1.9 miles. It also provides for rehabilitation of existing revetments and jetties, extension of existing jetties and provision of sand bypassing facilities. Preconstruction planning including a model study was initiated in 1967, and is under way.

l. Shinnecock Inlet. This inlet is situated on the south shore of Long Island about 95 miles east of the Battery, New York City, and connects the Atlantic Ocean with Shinnecock Bay. The existing project authorized in 1960 provides for an entrance channel 10 feet deep and 200 feet wide from the Atlantic Ocean to Shinnecock Bay thence an inner channel 6 feet deep and 100 feet wide to the Long Island Intracoastal Waterway, a total distance of 1.7 miles. It also provides for rehabilitation of existing revetments and jetties, extension of existing jetties and provision of sand bypassing facilities. No work has been done.

CONNECTICUT

Description and Status. Authorized Federal beach erosion control projects are described as follows:

a. Greenwich Point Park Beach, Greenwich. The project, authorized in 1958, and amended in 1962, provides for widening about 2,800 feet of the public beach to a width of 125 feet by direct placement of sand. A contract was awarded by the State of Connecticut in 1959

to construct the project by the placement of fill by hydraulic dredge. This work was not accomplished as suitable sandfill could not be located in available borrow areas.

b. **Cummings Park Beach, Stamford.** The project, authorized in 1958, provides for widening approximately 1,000 feet of the public bathing beach to 125 feet by direct placement of sandfill, extending the existing groin in the central portion of the project to a length of 400 feet, and raising the inshore end of the existing jetty at the western end of the project.

Construction of the project was completed in 1960.

c. **Cove Island Beach, Stamford.** The project, authorized in 1958, provided for widening approximately 1,200 feet of beach along the east shore of Cove Island to a width of 125 feet by direct placement of sandfill and construction of an impermeable jetty 400 feet long at the east limit of the fill. Construction of the project was completed in 1958.

d. **Calf Pasture Beach, Norwalk.** The project, authorized in 1958, provides for widening approximately 2,200 feet of beach to 125 feet by direct placement of sandfill, and lengthening two existing riprap groins to 400 feet. Construction of the project was completed in 1959.

e. **Compo Beach, Westport.** The project, authorized in 1950, provides for widening to 100 feet the beaches east and west of Cedar Point about 2,600 and 1,100 feet long, respectively, by direct placement of sand, and construction of two impermeable groins 500 feet long, one at Hills Point at the eastern end of the improvement and one at the western end of the improvement. Construction of the groins was completed in 1956. Placement of sandfill was completed in 1959.

f. **Sherwood Island State Park, Westport.** The project, authorized in 1950, provides for widening to 150 feet about 6,000 feet of beach, by direct placement of sandfill, with an additional width of 100 feet for a distance of 1,000 feet each side of Sherwood Point; the construction of two training walls 400 to 500 feet long at Burial Hill Creek at the eastern end of the sandfill; and the construction of an impermeable groin 500 feet long at the western end of the improvement. Construction was completed in 1957.

g. **Burial Hill Beach, Westport.** The project, as authorized in 1950, provided for widening the beach to 100 feet by direct placement of sand. It was contingent upon construction of a 400-foot training wall at Burial Hill Creek at the west limit of the fill under a project adopted for Sherwood Island State Park. The project was completed in 1957.

h. **Southport Beach, Fairfield.** The project, as authorized in 1950, provides for widening to 100 feet about 700 feet of shore near the western end of the beach, by direct placement of sand, and construction of an impermeable groin 400 feet long at the west end of the improvement. The groin was completed in 1956 and placement of the beach fill was completed in 1958.

i. **Sasco Hill Beach, Fairfield.** The project, as authorized in 1950, provides for widening to 100 feet about 900 feet of beach in the central portion of this section of shore, by the direct placement of sandfill, and for construction of an impermeable groin 400 feet long at the western end of the improvement. Construction of the project was completed in 1958.

j. **Jennings Beach and Ash Creek, Fairfield.** The project, authorized in 1950, provides for construction of an impermeable jetty 800 feet long, extending southeasterly from the west side of the mouth of Ash Creek and, if necessary, dredging an inlet channel and jetty foundation through the outer bar. The jetty was constructed by the Town of Fairfield in 1951.

k. **Seaside Park, Bridgeport.** The project, authorized in 1954, provides for widening to 125 feet, by direct placement of sandfill,

approximately 8,800 feet of shore. Construction was completed in 1957.

l. **Short Beach, Stratford.** The project, authorized in 1954, consists of widening to 125 feet, by direct placement of sandfill, about 2,500 feet of beach now used for public bathing, which includes the southern half of the shore in front of existing cottages which closely border the shore between Short Beach and the basin. The project was completed in 1955 by placement of sand dredged from the Housatonic River navigation project.

m. **Silver Beach to Cedar Beach, Milford.** The project, authorized in 1954, as amended in 1962, consists of widening to 100 feet, by direct placement of sand, 15,600 feet of shore along Silver Beach and Meadows End (the point opposite Charles Island) and along Myrtle, Walnut, Laurel, and Cedar Beaches, with added widening of 150 feet around Meadows End. It calls for construction of 11 impermeable groins 350 to 400 feet long, if experience indicates that structures are needed to assist sandfill retention.

n. **Gulf Beach, Milford.** The project, authorized in 1954, provides for widening to 100 feet about 1,200 feet of beach by direct placement of sand. Construction was completed in 1957.

o. **Woodmont Shore, Milford.** The project, authorized in 1954, provides for widening to 100 feet, by direct placement of sand, 500 feet of shore in the first pocket beach west of Merwin Point (about one mile southwest of the West Haven city line), widening to 100-150 feet, 3,500 feet of shore from Chapel Street (at the northeast side of Merwin Point) northerly to a point about 400 feet north of Anderson Avenue, and construction of 5 impermeable groins 300 to 400 feet long. Construction of the project was completed in 1959.

p. **Prospect Beach, West Haven.** The project, as authorized in 1954, provides for widening to 100 feet, by direct placement of sandfill, about 6,000 feet of beach extending from Ivy Street (about 1,500 feet southwest of Bradley Point) southward to a point about 350 feet south of South Street, with an added 50-foot widening to the south end of the fill, and construction of 8 impermeable groins, each 330 feet long. The project was completed in 1957.

q. **Lighthouse Point Park, New Haven.** The project, authorized in 1958, provided for the construction of an impermeable groin 380 feet long at Lighthouse Point. The groin was completed in 1958.

r. **Guilford Point Beach, Guilford.** The project, authorized in 1958, provides for widening to 125 feet approximately 400 feet of beach by direct placement of sandfill, and construction of an impermeable groin, 300 feet long, at the east end of the fill.

The groin was constructed in 1957 and placement of sandfill was completed in 1959.

s. **Middle Beach, Madison.** The project, as authorized in 1954, provides for revetment fronting 700 feet of seawall by placement of riprap for a width of 20 feet. Construction was completed in 1957.

t. **Hammonasset Beach State Park, Madison.** The existing project, authorized in 1954, provided for widening the beach, constructing two impermeable training walls at Toms Creek at the western end of the sandfill, and an impermeable groin at the eastern end of the sandfill at Hammonasset Point. Work was accomplished in 1955.

RHODE ISLAND

Description and Status. Federal beach erosion control projects authorized are described as follows:

a. Napatree Beach, Westerly (inactive). The project, authorized in 1954, called for construction of a sand barrier to prevent landward movement of the beach and for construction of three groins if needed. Fill was placed on the beach during improvement dredging at Watch

Hill Cove in 1949 and local interests constructed a groin to retard erosion. The project was classified as inactive in 1958 as local interests have taken no further action to complete the project and have leased part of the public beach to a private club.

b. Misquamicut Beach, Westerly. The project, authorized in 1960 and amended by the River and Harbor Act of 1962, called for widening approximately 3,250 feet of beach generally to a 150-foot width by direct placement of suitable sandfill and installation of sand fences. The State is eligible for Federal assistance to the extent of 70 percent of the costs of beach replenishment over a 10-year period from initial nourishment.

The sandfill was placed in July 1959 and the sand fences constructed in May 1960 under the direction of the State of Rhode Island.

This project was incorporated in the multiple purpose project, Westerly, Rhode Island, as authorized by the Flood Control Act of 1965.

c. Matunuck Beach, South Kingston. The project, authorized in 1960 and amended by the River and Harbor Act of 1962, called for widening approximately 3,830 feet of beach generally to a 150-foot width by direct placement of suitable sandfill, construction of 8 groins and installation of sand fences; the construction of groins was to be deferred pending demonstration of need, except for the most easterly groin and that near the middle of the shore frontage.

The project was incorporated in the multiple-purpose project for Point Judith, Rhode Island, authorized by the Flood Control Act of 1962. No work has been done on the project.

d. Sand Hill Cove Beach, Point Judith. The project, authorized in 1954, called for widening the beach for a length of about one mile an average of 65 feet by direct placement of sand, constructing a barrier to landward sand movement and, if necessary, construction of 10 impermeable groins.

The portion of the existing project along publicly-owned shore has been completed. A steel bulkhead and 5 groins have been constructed and the beach has been widened by the placement of sandfill. Construction of the remaining 5 groins has been deferred.

e. Narragansett Pier, Narragansett. The project, authorized in 1954, and amended in 1962 calls for widening the beach between Upper Pier and Narrow River, an average of 125 feet by direct placement of sand and constructing 7 impermeable groins and a barrier to landward sand movement.

In lieu of the groin system responsible local interests may adopt the plan for artificial beach building with such maintenance methods as they desire, subject to approval by the Chief of Engineers. No work has been done on the existing project.

This project was incorporated in the multiple-purpose project for Narragansett Pier, Rhode Island, authorized by the Flood Control Act of 1962.

f. Cliff Walk, Newport. The project, authorized in 1965, provides for protective measures from the western end of Newport Beach westward to the eastern end of Bailey Beach, a distance of 18,000 feet. The measures include intermittent reaches of backfill, dumped riprap stone slope revetment, mounds and breakwaters; concrete seawalls, toe walls; and grading and surfacing Cliff Walk. Local interests are required to maintain existing protective structures, restore eroded sections of the walkway and assure public access and administration of the walkway.

Planning has been completed. The contract for construction of the project was awarded in May 1971.

MASSACHUSETTS

Description and Status. Federally authorized beach erosion control projects are described as follows:

a. Clark Point, New Bedford. The project,

authorized in 1962, calls for beach widening to a minimum of 100 feet in width along 1,600 feet of the City beach, raising the inshore end of one existing groin near the northern end of the project and extending two other existing groins. No work has been undertaken.

b. Oak Bluffs Town Beach, Martha's Vineyard. The project, authorized in 1967 under Section 103 of the 1962 River and Harbor Act, as amended in 1965, calls for widening 1,200 feet of town beach with a width ranging from 150 to 200 feet decreasing gradually northward and construction of an impermeable terminal groin at the southern extremity of the beach. Preconstruction planning has been completed. It is anticipated that construction will be accomplished in the fall of 1971.

c. Provincetown Beach, Provincetown. The project, authorized in 1960 for the State beach (contained within the Cape Cod National Seashore), calls for widening about 1,600 feet of beach to a 125-foot width by direct placement of sandfill, construction of 4 groins and about 1,200 feet of concrete seawalls. The placement of sandfill is to be deferred until it is ascertained that the groins will not fill naturally to provide a satisfactory beach. No work has been done on the project.

d. Thumpertown Beach, Eastham. The project, authorized in 1960, calls for widening about 1,500 feet of town-owned beach to a 125-foot width by direct placement of sandfill and the construction of one groin at the northern end of the project. No work has been done on the project.

e. Town Neck Beach, Sandwich. The project, authorized in 1960, calls for widening about 6,500 feet of public beach between Sandwich Harbor and the east jetty at the eastern entrance of Cape Cod Canal, to a 125-foot width by direct placement of sandfill, raising the inshore end of the jetty and periodic placement of sandfill over a 10-year period of the first replenishment. In 1966 the State constructed two groins and due to the departure from the authorized plan, eliminates Federal participation in the cost of periodic nourishment. No work has been done on the project.

f. Plymouth Town Beach, Plymouth. The project, authorized in 1960, calls for widening about 1,300 feet of beach by direct placement of suitable sandfill; the construction of two groins and a 165-foot long concrete apron. Construction of the seawall and apron was completed in 1961 and the two groins in 1968.

g. Brant Rock, Marshfield. The project, authorized in 1960, calls for protection of the town beach, existing seawall and an adjoining public street, and calls for widening about 2,700 feet of beach by direct placement of sandfill and raising the inshore end of an existing jetty. No work has been done on the project.

h. North Scituate Beach, Scituate. The project, authorized in 1960 for protection of the beach and an adjoining seawall and public street, calls for widening about 2,500 feet of beach to a 125-foot width by direct placement of sandfill. The project was completed in 1967.

i. Nantasket Beach, Hull. The project, as authorized in 1970, calls for beach widening to an average width of 190 feet along about 6,800 feet of beach fronting the Metropolitan District Commission Reservation. It authorizes Federal participation in the first cost and the cost of periodic placement of sand fill for a period of the first 10 years of project life. Preparation of final plans and specifications by the Corps of Engineers is dependent on authorization of funds.

j. Wessagussett Beach, Weymouth. This project, authorized in 1960, calls for widening approximately 1,000 feet of the beach in the Wessagussett Road section to widths of 35 to 125 feet by direct placement of suitable sandfill, construction of a groin and appurtenant drainage structures. In the Regatta Road and River Street sections the project calls for widening about 1,000 feet of beach to a

general width of 125 feet by direct placement of sandfill, construction of a groin and construction of two stone mound walls. The project is complete.

k. **Quincy Shore Beach, Wollaston.** The project, authorized in 1954, calls for placing approximately 380,000 cubic yards of sand and gravel along an 8,500-foot sector of the beach; constructing a 5,100-foot section of concrete encased steel sheet pile bulkhead with a top elevation of 18 feet above mean low water; constructing a 325-foot length of concrete seawall; constructing a culvert at Sachem Creek; and extending existing drains across the beach to a discharge seaward of the recommended fill. The work was completed in 1959.

l. **Winthrop Beach, Winthrop.** The project, authorized in 1950, calls for reconstructing and raising the elevation of portions of the existing seawall, protecting the seawall with riprap; constructing eight stone groins and placing sandfill between the groins. Construction of the project was completed in 1959 with the exception of three groins. The Commonwealth of Massachusetts has plans for replenishing the beach and construction of the additional groins in 1971.

m. **Revere Beach, Revere.** A project, authorized in 1954, called for placing 522,000 cubic yards of sandfill along 13,700 feet of beach. About one-third of the sandfill was placed in 1954 along 5,000 feet of beach at the southern end of the project area.

A restudy of this work in conjunction with Nantasket Beach, resulted in a revised project authorized in 1970 calling for direct placement of suitable sandfill along about 13,700 feet of shorefront providing a beach width of about 200 feet above mean high water.

Strategically located groins are included in the project deferred for future construction, if experience indicates their needs.

Federal participation in the first cost and the cost of periodic artificial placement of sandfill on the beach for the first 10 years of the project life are authorized.

n. **Lynn-Nahant Beach, Lynn and Nahant.** The project, authorized in 1954, calls for placement of approximately 172,000 cubic yards of sand along 2,600 feet of beach providing a backshore elevation of 18 feet above mean low water, and construction of a stone mound with a top elevation of 18 feet above mean low water extending along 6,500 feet of shorefront from the southern extremity of the beach fill. No work has been done on the project.

NEW HAMPSHIRE

Description and Status. Federal beach erosion control projects authorized are as follows:

a. **Hampton Beach, Hampton.** The original project for restoration, protection and improvement of the State-owned public beach at Hampton was authorized in 1954 and constructed in 1955. This work involved direct placement of sandfill to widen about 5,200 feet of beach north of Haverhill Street to a general width of 150 feet, with an added 25-foot widening along 1,250 feet of the northern end of the fill area.

The 1962 River and Harbor Act modified the project by authorizing Federal participation in the costs of nourishing the beach for a 10-year period by the periodic placement of sandfill and constructing an impermeable groin near the northern end of the beach. The groin was constructed in 1965 in conjunction with the jetty modification work at Hampton Harbor. Replenishment of the northerly 2,200 feet of beach to authorized project width was completed in 1965 by the placement of sandfill obtained from dredging within Hampton Harbor.

b. **North Hampton Beach, Hampton.** The project, authorized in 1962, provides for widening about 1,600 feet of State-owned shore at the northern end of North Hampton Beach to a general width of 150 feet by the

direct placement of sandfill, and for constructing an impermeable groin at the southern limit of sandfill. Federal participation in the project is contingent upon local interests constructing adequate parking facilities to meet and promote increased public use of the beach.

c. Wallis Sands State Beach, Rye. A restoration and improvement project for the State-owned shore at the northern end of Wallis Sands Beach was authorized by the 1962 River and Harbor Act. The authorization called for widening about 800 feet of beach to a general width of 150 feet by direct placement of sandfill, and for constructing an impermeable groin at the southern limit of sandfill. The work was completed in 1963.

MAINE

There are no Federally authorized projects in the State of Maine.

E.

AUTHORIZED FEDERAL SURVEY STUDIES

E. AUTHORIZED FEDERAL SURVEY STUDIES

Currently authorized Corps of Engineers studies which pertain to beach erosion control are described in this section. A bibliography at the end of this report lists pertinent completed studies.

1. REGIONAL AND BASIN STUDIES

North Atlantic Regional Water Resources Study—This study, scheduled for completion in 1971, is one of 20 regional comprehensive water and related land resources studies being conducted throughout the United States under guidelines established by the Water Resources Council. The geographic area covered by the study includes all river basins draining into the Atlantic Ocean north of the Virginia-North Carolina boundary, portions of the Lake Champlain drainage area within the United States, and St. Lawrence River drainage within New York State below the international boundary. The study, includes consideration of problems along coastal and estuarine areas from Virginia to Maine.

Chesapeake Bay Basin—This study, currently under way, is comprehensive in scope and includes the entire Chesapeake Bay and its tidal tributaries. It will provide an appraisal of the water resources needs and of the economic interrelations among the several portions of the basin. Water resources being considered in the study include navigation, fisheries, flood control, noxious weeds, water pollution, water quality control, beach erosion and recreation. Future progress on the study is contingent on appropriation of funds.

Great South Bay, New York—This study is investigating Great South Bay and adjoining waters of Hempstead, South Oyster, Moriches and Shinnecock Bays as well as tributaries thereto with respect to water utilization and control, including but not limited to navigation, fisheries, flood control, control of noxious weeds, water pollution, water quality control, beach erosion and recreation. Scheduled for completion in 1971 is a reconnaissance type study of conditions in the bays which will be used as a basis for determining the scope of an overall study.

2. VIRGINIA

Four Federal survey studies have been authorized in the state and are described as follows:

Virginia Beach—A beach erosion control and hurricane protection study of the 38 miles of Virginia Beach shoreline is under way. The Division and District engineers have recommended structural improvement for beach erosion control and hurricane-tidal flood protection in the area between Rudee Inlet and 89th Street and consisting of the placement of a protective beach to elevation 10; a new sheet pile and concrete cap wall plus riprap between Rudee Inlet and 57th Street; and the building up of existing sand dunes from 57th to 89th Streets. The protective beaches and dunes would be maintained by periodic sand replenishment.

Tangier Island—A reconnaissance study for Tangier Island is being conducted under the general continuing authority of Section 103 of the River and Harbor Act of 1962, as amended, and is concerned with erosion along the western shoreline of Tangier Island. The report is scheduled for completion in 1971.

Westmoreland State Park—A reconnaissance study of Westmoreland State Park is being conducted under the general continuing authority of Section 103 of the River and Harbor Act of 1962, as amended, and is concerned with erosion along the Potomac River shoreline of the Park. The report is scheduled for completion in 1972.

Jamestown Island—A reconnaissance study for Jamestown Island is being conducted under the general continuing authority of Section 103 of the River and Harbor Act of 1962, as

amended, and is concerned with erosion along the island's western shoreline. The report is scheduled for completion in 1971.

3. MARYLAND

Two Federal survey studies have been authorized in the State and are described as follows:

Atlantic Coast of Maryland and Assateague Island—The Atlantic Coast of Maryland and Assateague Island, Virginia, is a study of survey scope authorized by the House Committee on Public Works on 19 June 1963 and by the Senate Committee on Public Works on 13 February 1967. The report, a combined hurricane-beach erosion control study of Maryland's entire Atlantic coastline, is scheduled for completion in 1972.

Point Lookout State Park—The study of Point Lookout State Park, St. Mary's County, Maryland, at the mouth of the Potomac River, is being conducted under the general continuing authority of Section 103 of the River and Harbor Act of 1962, as amended, and is concerned with erosion along the Chesapeake Bay shore of the park. The report is scheduled for completion in 1972.

4. DELAWARE

Two Federal survey studies have been authorized in the State and are described as follows:

Lewes, Broadkill Beach—These two areas are being studied separately under authority provided by Section 103 of the River and Harbor Act of 1962, as amended. Reports for a small beach erosion control project at Lewes and Broadkill Beach are scheduled for completion in 1972.

5. NEW JERSEY

Three Federal survey studies have been authorized in the State and are described as follows:

Sandy Hook to the Delaware Bay Entrance of the Cape May Canal—The latest authorized Federal study covering the New Jersey ocean coast is a combined navigation and beach erosion control study covering the reach from Sandy Hook to the Delaware Bay Entrance of the Cape May Canal. The beach erosion control portion of this study is a cooperative study conducted by the Corps of Engineers, United States Army and the State of New Jersey. One of the major purposes of the study is to develop plans of improvement for stabilization of inlets and for protection against shoreline erosion. For the purpose of this study, the N.J. coast was divided into four priority groups as follows: Group I—Great Egg Harbor Inlet to Stone Harbor; Group II—Hereford Inlet to the Delaware Bay Entrance of the Cape May Canal; Group III—Barnegat Inlet to Longport; and Group IV-Sandy Hook to Island Beach State Park. The study of the Group I area has been completed and is published as House Document No. 91-160, 91st Congress, 1st Session. The reports for Groups II, III, and IV are under way and are scheduled for completion in 1972. The plans of improvement considered in these reports provide for stabilization of the natural inlets by means of jetties or breakwaters; sand transfer to downdrift beaches by dredging in a deposition basin; and shore protection by means of beach fill, dune fill, sand fences, bulkheads and groins.

Raritan Bay and Sandy Hook Bay—A hurricane protection study is in progress for the areas of Raritan Bay to Sandy Hook Bay, New Jersey which were not included in the Federal project authorized in 1962. The report is scheduled for completion in 1971.

Neptune City—A reconnaissance study for Neptune City is being conducted under the general continuing authority of Section 103 of the River and Harbor Act of 1962, as amended, and is concerned with restoration of the beach

at Memorial Park Beach. The study is scheduled for completion in 1971.

6. NEW YORK

The Federal survey studies authorized for the State are as follows:

Coney Island—A beach erosion control and hurrican protection study of this area is under way. The study gives consideration to a plan of improvement for beach erosion control and hurricane protection for the Coney Island area. The beach erosion control phase of the considered improvement would provide for beach widening along the recreational beaches along the Coney Island shore. The report is scheduled for completion in 1972.

South Shore of Long Island, Nassau County—There is an authorized beach erosion and hurricane study for the 10 miles from Jones Inlet to East Rockaway Inlet which is under way. The study is considering protection of the oceanfront against erosion and protection of low-lying areas against tidal inundation. This report is scheduled for completion in 1972.

North Shore of Long Island, Nassau County—A hurricane protection study has been authorized for this reach, but has not yet been funded. A reconnaissance study is being conducted under the general continuing authority of Section 103 of the River and Harbor Act of 1962, as amended, and is concerned with erosion at Glenn Cove and Lattingtown fronting Long Island Sound.

Eastern Forks of Long Island, Suffolk County—A hurricane protection study has been authorized for this reach, but has not yet been funded.

North Shore of Suffolk County—A beach erosion control and hurricane protection study of the 87 miles of the North Shore of Suffolk County has been completed. The Division and District engineers have recommended adoption of a shore protection improvement at Sunken Meadow State Park, New York, including the shore of Callahans Beach.

City Island and Vicinity—A study of the shores of City Island, New York and vicinity in the interest of beach erosion control, hurricane protection and related purposes as authorized by Resolution of 14 April 1964 by the Committee on Public Works of the United States, House of Representatives is presently under way.

7. CONNECTICUT

There is one beach erosion control study authorized in the State of Connecticut described as follows:

A study was authorized by the Senate Committee of Public Works in 1968 to review the cooperative study for beach erosion control of the Connecticut shoreline from Ash Creek to Saugatuck River and other pertinent reports to determine the advisability of modifying the recommendations pertaining to Sherwood Island State Park contained therein. This study is currently in progress and a beach erosion control report is scheduled for completion in Fiscal Year 1972.

8. RHODE ISLAND

There are presently no authorized beach erosion control studies for the State of Rhode Island.

9. MASSACHUSETTS

There are four authorized beach erosion control studies for the Commonwealth of Massachusetts, described as follows:

South Shore of Barnstable. At the request of the town of Barnstable a study was authorized by the Committee on Public Works, House of Representatives in 1969 for a survey of the shores of the town of Barnstable, in the interest of beach erosion control and related purposes.

There are five separate reaches of town-owned beaches along the south shore. There is no existing Federal beach erosion control project within the area. The town officials and

local populace desire a study in the interest of beach erosion control and related purposes to determine practical and economical measures to improve the beaches with Federal participation in the cost.

The study is currently proceeding with field investigations, meeting with the town, obtaining of data and necessary office preparation required for holding a public meeting, the latter part of the summer of 1971.

Easterly Shores of Cape Cod, Provincetown, Truro, Wellfleet, Eastham, Orleans and Chatham. At the request of the concerned towns, a study was authorized in 1970 by the Committee on Public Works of the House of Representatives for a survey of the easterly shores of the outer arm of Cape Cod extending from Provincetown to the southern extremity of Nauset Beach, in the interest of beach erosion control hurricane protection and allied purposes. The study is currently unfunded.

Gay Head Cliffs, Gay Head, Martha's Vineyard. A study was authorized in 1963 by the Committee on Public Works of the United States Senate for a survey of the coastal area of Gay Head and adjacent shores as may be necessary in the interest of beach erosion control and related purposes.

Gay Head Cliffs has been designated as a landmark of National significance. The town, State and other interests, concerned that the Cliffs may deteriorate, desire that a study be made to determine possible methods of preserving the Cliffs.

The problem is unique and very complex in nature, particularly as to the geological structure of the Cliffs. An engineering consulting firm with expertise in soils and foundation design was contracted to make a feasibility type study for preservation of the Cliffs. Their study is currently being reviewed by the Corps. A public meeting will be held following completion of the report to discuss findings and conclusions and ascertain the current views of concerned interests.

10. NEW HAMPSHIRE

There is one beach erosion control study authorized for the State of New Hampshire covering two State beaches, described as follows:

At the request of the President of the State Senate, a study was authorized in 1970 by the Committee on Public Works for a survey of the shores of the State of New Hampshire at Hampton North Beach in the town of Hampton and at Foss Beach in the town of Rye and such adjacent areas as may be necessary in the interest of beach erosion control and related purposes.

Both beaches are State-owned and are located about 10 miles south of Portsmouth, New Hampshire and 60 miles north of Boston, Massachusetts. The local populace desires additional recreational beach area in view of the rapidly increasing toursit and vacation population and in view of the overcrowded conditions existing every summer at the two developed beaches of the area, Hampton and Wallis Sands Beaches. The survey study is presently unfunded.

11. MAINE

There is one beach erosion control study authorized for the State of Maine, described as follows:

A study was authorized in 1970 by the Committee on Public Works of the United States Senate for a survey of the South Coastal Urban Areas of Maine from the New Hampshire State line to the Kennebec River in the interest of beach erosion control and related purposes. Particular emphasis is given to Drakes Island, Long Sands Beach, Old Orchard Beach, Kennebunk Beaches, Crescent State Beach and Popham State Beach in the towns of York, Wells, Old Orchard Beach, South Portland and Phippsburg, Maine.

The overall problem for the reach of shorefront contained between the New Hampshire

State line and the Kennebec River is one of lack of protective recreational beaches rather than one of tidal flooding.

The study is being made as separate reports. Reports for Long Sands Beach and Short Sands Beach, York, Maine, have been completed. Studies are currently continuing on other beaches and are well advanced for Drakes Island, Old Orchard Beach and Crescent State Beach. In addition to the separate reports, an overall report will be completed discussing the beach erosion problems for the entire area.

F.

STATE AND LOCAL SHORE PROTECTION PROGRAMS

F. STATE AND LOCAL SHORE PROTECTION PROGRAMS

This section of the Regional Inventory Report gives information on State and local shore protection programs broken down for each State in the North Atlantic Region. Table 2 at the end of the report summarizes these programs. Provided along with the data on shore programs is general descriptive information on the types of protective measures which have been undertaken by non-Federal agencies and private interests.

1. VIRGINIA

Virginia has assisted on the Federal project for Virginia Beach by making specific appropriations to the local Erosion Commission. It has no general policy for assistance applicable to other localities.

2. MARYLAND

In 1929, the State of Maryland, recognizing the problem of shore erosion, established a Waterfront Commission "to recommend plans and policies for protection of water fronts from erosion." In 1941, the Waterfront Commission was merged with the Department of Geology, Mines, and Water Resources (now the Maryland Geological Survey). From 1947 to 1964, the Department, upon the request of shore front property owners, inspected shore fronts and made recommendations concerning proper methods of protection. In 1964, the Maryland Legislature authorized a shore erosion control program designed to financially

County (Maryland)	Length of Shoreline (Miles)	Length of Shoreline Protected (Miles)	Percent Shoreline Protected
Western Shore			
Anne Arundel	491	66	16
Calvert	143	19	13
Baltimore	209	14	7
Prince Georges	44	3	7
St. Marys	297	13	4
Harford	139	4	3
Charles	183	5	3
Sub-total	1,434	124	9
Eastern Shore			
Kent	268	21	8
Cecil	200	11	6
Queen Annes	323	14	4
Wicomico	89	4	4
Talbot	442	15	3
Caroline	66	1	2
Dorchester	498	8	2
Somerset	619	4	1
Worcester	407	0	0
Sub-total	2,912	78	3
TOTAL	4,346	202	5

aid all property owners up to 25 percent of the total cost of protection against erosion. The program was administered by an agency now under the Maryland Department of Natural Resources. In 1967, the State's financial participation in each State-approved project was increased to 50 percent. In 1970, the Legislature repealed this program by limiting its participation to the lending of construction funds, without interest, for shore erosion control measures to qualified applicants. The design of the control measures is a State responsibility.

The preceding tabulation lists, by county, the estimated percentage of total tidal shoreline protected regardless of its present structural soundness. Anne Arundel County leads all counties in percentage of protection. The Western Shore probably leads the Eastern Shore in percentage of protection because the high residential shorefront land values on the Western Shore make the loss of relatively small areas prohibitive, whereas the Eastern Shore is predominantly rural with large waterfront acreages.

3. DELAWARE

The State of Delaware has taken an active part in shore protection through use of beach and dune fill and construction and maintenance of groins. Municipalities have been assisted generously in shore protection measures where erosion has been critical. Each project must be approved individually by the State Legislature. The State bears 100 percent of the non-Federal cost of Federal shore protection projects and finances the entire cost of local projects.

The State placed a total of 1,039,000 cubic yards of beach fill along the ocean coast since 1954. Of this total, all but 100,000 cubic yards was authorized for Federal participation in cost.

The State has succeeded in raising the overall elevation of the emergency protective dunes placed by the Corps of Engineers after the storm of March 1962 by the use of additional sand fence. The State placed a total of 28 miles of sand fence in two rows, one parallel to the fence originally placed by the Corps of Engineers and the other parallel but on top of the sand accumulated as a result of the first two fences.

The State Highway Department has also supplemented the sand fence construction program with an experimental operation, commenced in 1964, involving the use of a bulldozer to move sand from a built-up berm to higher elevations, leaving the lowered berm to be restored by natural forces. The bulldozer operation is repeated whenever additional sand has accumulated on the berm, sometimes in a few days, sometimes in weeks. The State estimates that as a result of these operations, several hundred thousand cubic yards of sand have been salvaged for the build-up of beach and protective dunes. In order to stabilize the dunes, the State has planted rows of beach grass at some locations on the inland sides of the dunes.

In addition to the above, the State has done maintenance work to existing groins and/or constructed new ones in Rehoboth and Bethany Beaches dating to 1922. A total of 26 groins are located in these communities. The latest such construction was a timber groin at Rehoboth Beach in 1964. In 1969 nine existing groins at Rehoboth Beach were extended. These extensions were completed on 8 August 1969 and ranged from 30 to 85 feet in length.

The following tabulation summarizes the beach fill operations by the State along the Delaware Bay shore:

Location	Quantity of Beach Fill	Year Placed
Kitts Hummock	80,000	1961
South Bowers	20,000	1961
Slaughter Beach	49,000	1958
Slaughter Beach	165,000	1961
Broadkill Beach	76,800	1957
Broadkill Beach	120,000	1961
Lewes	48,000	1954
Lewes	400,000	1957
Lewes	20,000	1961

The State initiated an extensive program of groin construction in 1940 to stabilize the shoreline at Slaughter Beach. To date, 20 groins have been constructed. The groin system at Broadkill Beach consists of 5 timber groins constructed by the State between 1950 and 1954. Between 1948 and 1950 the State constructed 6 timber groins at Lewes.

In 1964 the Delaware River and Bay Authority constructed a stone breakwater 2,550 feet long at the east end of Lewes about 2 miles east of Roosevelt Inlet. The breakwater was constructed normal to the shore at the inner end and is hooked to the east at the outer end. The structure was constructed to protect the ferry terminal facilities at the Cape May-Lewes Ferry System which has been in operation since July 1964.

4. NEW JERSEY

Shore protection in the early stages of development of the New Jersey coast was done largely by individuals and local groups. The result was a wide variety of structures ranging from inadequate, flimsy groins and seawalls to well-engineered systems of protective structures capable of long and useful service. In the early 1920's the State of New Jersey began to furnish financial and technical assistance to municipalities in the protection of the shore. This assistance has continued to the present time.

The State has an annual appropriation from which it finances 75 percent of the cost of shore protection projects sponsored by lower subdivisions of government. On Federal projects the State finances 75 percent of the non-Federal share. The State has also cooperated with the Federal Government by participating in the cost of erosion control studies which have led to Federally authorized shore protection projects.

The most extensive shore protective works in the State are found along its Atlantic Coastline where there are hundreds of groins, bulkheads, seawalls and jetties. In the area north of Manasquan Inlet alone, there are 169 groins, 3 jetties and over 38,000 linear feet of seawalls.

Construction of protective works along the bay frontages has been somewhat less extensive than on the oceanfront. On the Raritan Bay and Sandy Hook Bay shores there are 115 groins, 6 jetties and some 34,000 feet of seawalls and bulkheads. Beach fill in this area amounting to 745,000 cubic yards was placed at Keansburg and Middletown Township in 1954 and 1957. Beach fill and bulkheads have been provided at Pine Beach and Beach Wood

in the Barnegat Bay area, and protective works were built at Pennsville and Penns Grove on the Delaware River where the erosion problem has been aggravated by waves generated by passing oceangoing vessels.

5. NEW YORK

The State of New York has a policy of financial assistance in the construction of shore protection improvements. The State contributes 70 percent of the cost of local shore protection improvements, with the counties or local governments contributing the remaining 30 percent.

The State has participated in making cooperative beach erosion control studies with the Federal Government. Several of these studies have led to authorized Federal beach erosion projects for New York State. In the case of authorized Federal projects, the counties or local governments are required to contribute 30 percent of the non-Federal cost of such projects and the remaining 70 percent is contributed by the State.

The City of New York provides for the cost of its shore protection improvements from its Capital Improvement Program. The City's shore protection works have generally been done by its Department of Parks. Work accomplished along its shores has been done by the City itself or in cooperation with the State of New York.

In Westchester and Nassau Counties there is no special authority for shore protection work. All such work is accomplished under their Capital Improvement Program. The town of Hempstead in Nassau County has formed a beach erosion district for implementing shore protection works.

In the past, participation with the State program for shore protection, Suffolk County and the municipalities therein has been by special acts of these bodies for furnishing of construction funds and cooperation. Some shore protection by hydraulic fill placement has been accomplished at several locations by Suffolk County with its own dredging plant in connection with navigation improvements.

The principal types of shore protective measures provided by State and other local governments along the reaches of the New York coast is as follows:

Staten Island, Fort Wadsworth to Arthur Kill	59 groins; a jetty; about 6,000 feet of seawalls, revetments and bulkheads; and sand fill.
Rockaway Inlet to Norton Inlet	31 groins; about 7,600 feet of revetments and bulkheads; about 1,400 feet of breakwaters; and sand fill.
East Rockaway Inlet to Rockaway Inlet	242 groins; about 25,300 feet of bulkheads; and sand fill.
Jones Inlet to East Rockaway Inlet	60 groins; a jetty; about 14,300 feet of bulkheads; and sand fill.

Fire Island Inlet to Jones Inlet	Massive sand fill and construction of an ocean parkway on the embankment; and some groins and bulkheads.
Fire Island Inlet to Montauk Point	Sand dunes; 4 jetties; and some groins and bulkheads.
Eastern Forks of Long Island	Numerous groins and bulkheads.
North Shore of Suffolk County	236 groins; 14 jetties; about 46,500 feet of seawalls, revetments and bulkheads; and sand fill.
North Shore of Nassau County	Numerous groins, seawalls and bulkheads; and sand fill.
New York City Shore on Long Island Sound from Westchester County Line to Throgs Neck	Numerous groins, seawalls and bulkheads; and sand fill.
Westchester County Shore on Long Island Sound	Numerous seawalls; and sand fill.

6. CONNECTICUT

The State of Connecticut has a very active coastal development program. This is demonstrated in a large part by past State cooperation with the Corps of Engineers in completing the beach erosion control study for the entire State shoreline. This study resulted in twenty authorized projects with all but two now having been constructed by the State. This record of construction is among the best in the country. The methods of financing by this State are of particular interest. The State has a general appropriation fund from which the projects are financed. On Federal projects the State requires local participation of one-half the non-Federal share, but on request of the local public agency the State would advance the local share and construct the project. Repayment of the advanced share in 20 years is required, but no interest is charged on the advanced funds. In addition, many plans of protection considered in the Federal study, but not recommended as Federal projects, have been constructed. On such improvements for publicly owned (other than State owned) purposes, the State pays two-thirds of the cost and the local agency one-third. Improvements for privately owned shores are paid one-third State and two-thirds local.

The State of Connecticut and local municipalities are very active in development of available public use shorefront. This has resulted in several coastal parks and saltwater bathing beach areas. They are actively engaged in expansion of these public use areas including essential public use facilities commensurate with recreational use requirements and financial capabilities.

The most common type of construction for backshore protection (bluffs and embankments) by State and local interests is by rock revetment, although there are sectors within municipal urban areas or backing a recreational beach where timber or sheet pile bulkheads and concrete seawalls have been used. Beach rest-

oration work by the State usually is accomplished through beach widening by direct placement of suitable sandfill attained from land sources although in a few cases the State has used dredged material in conjunction with a navigation improvement. The State has constructed many stone groin and jetty structures, in many instances the jetty terminating a beach at the entrance to a small recreational boat harbor. The groin structures have proven quite successful in several areas in compartmenting beach fill.

7. RHODE ISLAND

The State of Rhode Island participates on an equal cost sharing basis with local interests on construction of shorefront improvements. Federal projects constructed to date have been for State-owned recreational beaches. Therefore, all local funding of these projects have been by State funds directly appropriated for the work.

Generally, the types of improvements as developed by the State have been those related to attractive State Park Developments. The parks fronted by fine bathing beaches include Scarborough, Misquamicut and Sand Hill Cove State Beaches. Substantial parking, pavilions and bathhouse facilities are included within many of these recreational developments. The types of improvements constructed by the State and local interests have included beach and dune restoration, stone and timber groins, stone revetment, seawalls and bulkheads. Beach and dune restoration work by the State has been by direct placement of suitable sandfill. Sand fences placed along beach areas have been successful in holding wind blown sand within the backshore area for redistribution along the beach areas prior to the summer bathing season. The massive construction work such as seawalls and revetments frequently protect low coastal roads as well as private exposed property.

8. MASSACHUSETTS

The Commonwealth of Massachusetts has long had a policy of financial assistance in construction of shore protection improvements. In practice the State has an annual appropriation from which it will match local funds on non-Federal projects. Presumably these funds could also be used to pay one-half of the non-Federal share in the case of Federal projects, for major Federal projects requiring large sums of money by direct appropriations. The projects are normally constructed by the State Department of Public Works. The active program of the Commonwealth is demonstrated by the cooperative effort with the Federal government in completing studies for substantial portions of the shorefront resulting in Federal authorized projects for local and State-owned beaches. Several of the authorized projects have been constructed. Metropolitan District Commission Reservations and State Parks are among the major shorefront areas improved for recreational use by the Commonwealth.

The types of improvements undertaken by the Commonwealth or considered for future development have been the restoration of major public use beach areas, either owned by the Commonwealth or by cities and towns. The method of construction for these improvements usually were in accordance with plans developed in cooperative beach erosion control studies completed with the Federal government. Beach restoration by direct placement of suitable sandfill and stone groin construction was the common type of improvement for public beach areas, however, in some instances it included massive concrete seawall and stone mound construction along the backshore. Types of improvements used by the State and/or local interests along other sectors of the shorefront include: stone and timber groin construction, stone revetment and massive concrete seawalls. The Cape Cod area of Massachusetts and some sectors of the outer islands of Nantucket and Martha's Vineyard include

many areas where groins have been constructed to attempt to construct wider beaches by trapping sandfill within this area of the glacially constructed features mainly of erodible sand and unconsolidated deposits. The more massive type of construction consists of rock revetment, stone mound and concrete seawalls, front high bluffs areas or low coastal highways. A very successful type of improvement constructed by the Commonwealth in some areas has been the use of a massive precast concrete block with a seaward recurved face to deflect wave runup seaward with the blocks supported by stone revetment as a protection against undermining and to reduce the wave force of a breaking wave. The localities have constructed a variety of timber or steel bulkheading usually fronting the commerical and industrial properties of large developed cities or urbanized complexes.

9. NEW HAMPSHIRE

The State of New Hampshire has only a very short coast with much of it containing massive ledge outcrops affording substantial natural protection from wave attack. The great interest of the State in shorefront improvements is demonstrated by the State cooperation with the Federal Government in beach erosion control studies made for the entire shorefront and leading to Federal projects for the area. The State has participated with the Federal Government in construction of beach erosion improvements fronting State-owned property. The State has no special means of funding with local interests. Such funds would presumably have to be obtained through direct appropriations. The State has an active program of park development and a great interest in expanding public beach areas for much needed protection and recreational use, commensurate with financial capabilities.

The types of improvements completed by the State have been by direct placement of suitable sandfill and groin construction at the Federal projects such as at Hampton Beach and Wallis Sands State Park, in cooperation with the Federal Government. Other shore protection work by the State has been steel bulkheading, concrete seawalls or rock revetment fronting the seaward exposure of a State highway. Private property owners have constructed concrete seawalls, timber bulkheads and stone revetment fronting cottage developments.

10. MAINE

Although the State of Maine has participated with the Federal Government in the cost of Federal navigation projects, there are at this time no authorized beach erosion control projects. It is likely that with development of such improvements that the State would participate financially similar to their cooperation on the navigation projects. The great interest of State and local municipalities in shorefront development is shown by the many State park developments improved by the State or continuing to be developed along the entire coast. The local municipalities within financial capabilities, have developed facilities at limited beach areas to encourage recreational use.

The State and local interests have constructed a variety of protective improvements along exposed backshore areas. The State improvement has mainly been confined to construction of concrete seawalls or stone revetment fronting coastal highways. Local municipalities and private property owners have constructed massive rock revetment, concrete seawalls or timber bulkheading fronting cottage developments, commercial and industrial developments and low coastal roads. Most protective improvements have been confined to the shorefront southwest of the Kennebec River. The improvements northeast of the Kennebec River although similar, are only along scattered locations since most of the beach is of ledge rock or fronting rockfill structures affording natural protection.

G.

SUITABLE TYPE OF REMEDIAL ACTION

G. SUITABLE TYPE OF REMEDIAL ACTION

The types of remedial action considered suitable to protect the critical erosion areas described in Section C of this report are presented below. The costs given are based on preliminary order of magnitude type estimates. Data are summarized in Table 3.

1. VIRGINIA-CAROLINA LINE TO ISLE OF WIGHT COUNTY LINE

General Concepts. Except for the highly developed areas of Virginia Beach proper, much of the shore is undeveloped or developed for summer use only. Beaches for recreational use are important to these types of development. Therefore, beach restoration and periodic artificial placement of sand would be a suitable type of remedial action. In the more highly developed areas, bulkheading with fill would be essential.

Estimated Costs. Costs of beach restoration or bulkhead types of protection would depend to a great extent on the locality and extent of shore to be protected. It is estimated that effective protection could be provided for the shore along this reach for approximately $31,600,000.

2. ISLE OF WIGHT COUNTY LINE TO NEW KENT COUNTY LINE, VIRGINIA

General Concepts. Much of the shore protection already built along this reach consists of timber bulkheads, sometimes supplemented by short groins. These groins are frequently ineffective because of the scarcity of littoral drift. Many of the existing structures are in poor condition. As much of the shore is rather irregular, beach fills supplemented by groins to reduce the rate of loss may be more economic than beach fills alone. Bulkheads or sloped revetments would be a suitable type of remedial action where recreational beaches are not needed or desired.

Estimated Costs. Costs of beach restoration or bulkhead types of protection would depend to a great extent on the locality and extent of shore to be protected. It is estimated that effective protection could be provided for this reach for approximately $22,500,000.

3. GLOUCESTER COUNTY LINE TO KING GEORGE COUNTY LINE, VIRGINIA

General Concepts. Concepts given for the previous reach apply here also.

Estimated Costs. Protection could be provided for approximately $59,400,000.

4. EASTERN SHORE AND BARRIER ISLANDS OF VIRGINIA

General Concepts. A suitable type of remedial action to protect the barrier islands could be accomplished by constructing and maintaining sand fences along their windward backshores with revetment as needed.

Estimated Costs. It is anticipated that the cost of the protection for this reach would be approximately $26,000,000.

5. MARYLAND

General Concepts. In areas where beaches for recreational use are important, beach restoration and stabilization would be a suitable type of remedial action. For long reaches of shore, initial restoration and stabilization by periodic artificial placement of sand would possibly be feasible. Where recreational beaches are not needed, rock or concrete block revetments or bulkheads of steel, concrete, or timber could be used effectively with due consideration to protection against flanking.

Estimated Costs. Costs of beach restoration or bulkhead types of protection depend on the locality, extent of shore to be protected and availability of construction materials. The

estimated costs of protecting those reaches of shoreline considered critical are as follows:

Chesapeake Bay	
Anne Arundel County	$ 4,000,000
Baltimore County	2,700,000
Calvert County	3,200,000
Charles County	500,000
Harford County	500,000
St. Marys County	20,200,000
Cecil County	1,600,000
Dorchester County	11,000,000
Kent County	3,700,000
Queen Annes County	8,100,000
Somerset County	6,900,000
Talbot County	17,000,000
Atlantic Coastline	
Ocean City	$ 9,800,000
Assateague Island	14,500,000

6. CAPE HENLOPEN TO FENWICK ISLAND, DELAWARE

General Concepts. Available data indicate that the most suitable type of remedial action along the 24.5 miles of ocean shore would consist of placement of dune and beach fill, construction of bulkheads, placement of sand fences and planting of dune grass to stabilize the dunes.

Estimated Costs. The estimated cost of the remedial action proposed in the above mentioned analysis is $10,900,000.

7. REHOBOTH, INDIAN RIVER AND LITTLE ASSAWOMAN BAYS, DELAWARE

General Concepts. In view of the recommendations of the environmental study of Rehoboth, Indian River and Little Assawoman Bays, the tidal marshes and shoreline areas of these bays should be preserved in their natural condition to prevent any serious alteration in the ecology of the bay system. Any type of remedial action to prevent shoreline erosion should, therefore, be confined to such measures that are compatible with the environment. For the areas west of the west end of the Indian River Inlet, bulkheading with possible stone revetment may be required to protect against erosive tidal currents.

Estimated Costs. Costs of back stabilization would depend to a great extent on the locality and extent of shore to be protected. It is estimated that the cost of effective protection of the shoreline areas will be $1,130,000.

8. DELAWARE RIVER AND BAY SHORE OF DELAWARE CAPE HENLOPEN TO WILMINGTON

General Concepts. An analysis of available data indicated that for the reach between Pickering Beach and Lewes beach erosion control can best be effected by means of beach fill, dune fill, groin construction and maintenance of existing groins, periodic beach nourishment, sand fence and dune grass. The reach above Pickering Beach had not been studied. However, considering the lack of beach and the marshy nature of most of this reach, bank protection and stabilization is considered the most suitable type of remedial action where erosion is a problem. Bulkheads may be required in some areas.

Estimated Costs. The plans of protection presented in the above mentioned Federal Study Reports indicate only two areas where protective measures appear to be economically justified. These are at Broadkill Beach and Lewes. The estimated cost of beach protection in these areas is $282,000.

9. DELAWARE RIVER AND BAY SHORE OF NEW JERSEY CAPE MAY POINT TO PENNS GROVE

General Concepts. Bank protection and stabilization, where considered essential, is the most suitable type of remedial action for protection of the shore line in the marshy

areas, and for erosion control in the beach areas is beach fill. Bulkhead and revetment may be required in some areas where severe erosion has occurred along developed reaches.

Estimated Costs. The estimated costs of the remedial action proposed in the above mentioned analysis is $1,573,000.

10. ATLANTIC COST OF NEW JERSEY MANASQUAN INLET TO CAPE MAY POINT

General Concepts. The previously discussed Federal Survey Studies for the study area indicate that the most suitable type of remedial action consists of beach and dune fill, bulkheads in certain areas, goins, inlet stabilization and periodic transfer of sand across the inlets to sustain down-drift beaches.

Estimated Costs. The estimated cost of the remedial action considered in the above mentioned analysis is $84,000,000.

11. BARNEGAT BAY TO CAPE MAY HARBOR, NEW JERSEY

General Concepts. The most suitable type of remedial action for shore erosion control in areas having beaches is beach fill with periodic artificial placement of sand as required. In the marsh areas and low areas not having beaches, bank stabilization may require revetment or bulkheads where erosion is critical.

Estimated Costs. The estimated costs of the remedial action considered in the above mentioned analysis is $4,300,000.

12. SANDY HOOK TO MANASQUAN INLET, NEW JERSEY

General Concepts. Much of the shore is developed for summer recreational and residential use. Beaches for recreational use are important to this type of development and therefore beach restoration and periodic artificial placement of sand fill would be a suitable type of remedial action. Where inlets interrupt the flow of sand along the shore, bypassing of the sand to noursih downdraft shores warrants consideration. In areas where the shore bluffs are being cut back by erosion due to wave attack and surface runoff, the initial consideration for protection should be given to the toe of the bluff. The most suitable type of remedial action to provide this protection generally is by restoration of a protective beach which is of sufficient width and height to prevent wave attack on the toe of the bluff. If the method is not warranted in certain areas, then an alternative solution would be the construction of protective shore works such as riprap mounds and revetments, or bulkheads. The top elevations of these structures should be sufficient to dissipate energy of breaking waves and to contain wave runup. Once the toe of the bluff is protected, the bluff slope should be stabilized and protected against erosion from rainrall runoff and wind.

Estimated Costs. The estimated costs of the remedial action proposed in the above mentioned analysis is $48,960,000.

13. RARITAN BAY AND SANDY HOOK BAY, NEW JERSEY

General Concepts. Concepts given for the previous reach generally apply here also.

Estimated Costs. The estimated cost of the remedial action proposed in the above mentioned analysis is $2,300,000.

14. FORT WADSWORTH TO ARTHUR KILL, STATEN ISLAND, NEW YORK

General Concepts. Much of the shore is developed for recreational and residential use. Reaches for recreational use are important to this type of development and therefore beach

restoration and periodic artificial placement of sandfill would be a suitable type of remedial action. If this method is not warranted in certain areas, then an alternative solution would be the construction of protective shore works such as riprap mounds and revetments, or bulkheads. The top elevations of shore structures should be sufficient to dissipate energy of breaking waves and to contain wave runup.

Estimated Costs. The estimated first cost of beach restoration for shore protection by sandfill is $3,084,000.

15. ROCKAWAY INLET TO NORTON POINT, NEW YORK

General Concepts. Much of the shore is developed for recreational and residential use. Beaches for recreational use are important to this type of development and therefore beach restoration and periodic artificial placement of sandfill, with groins if needed, would be a suitable type of remedial action.

Estimated Costs. The estimated first cost of beach restoration for shore protection by sandfill is $3,084,000.

16. EAST ROCKAWAY INLET TO ROCKAWAY INLET, NEW YORK

General Concepts. Much of the shore is developed for recreational and residential use. Beaches for recreational use are important to this type of development and therefore beach restoration and periodic artificial placement of sandfill would be a suitable type of remedial action.

Estimated Costs. The estimated first cost of beach restoration for shore protection by sandfill is $5,280,000.

17. SOUTH SHORE OF LONG ISLAND, NASSAU AND SUFFOLK COUNTIES, NEW YORK

General Concepts. Concepts given for reach 12 generally apply here also.

Estimated Costs. The estimated first cost of beach restoration for shore protection by sandfill is $156,816,000.

18. SHORE OF GREAT SOUTH BAY AND ADJOINING LESSER BAYS, LONG ISLAND, NEW YORK

There are no critical erosion areas in this reach.

19. EASTERN FORKS OF LONG ISLAND, SUFFOLK COUNTY, NEW YORK

General Concepts. Concepts given for reach 12 generally apply here also.

Estimated Costs. The estimated first cost of beach restoration for shore protection by sandfill is $59,400,000.

20. NORTH SHORE OF LONG ISLAND, SUFFOLK COUNTY, NEW YORK

General Concepts. Much of the shore is undeveloped or developed for summer use only. Beaches for recreational use are important to this type of development. Concepts given for reach 12 generally apply here also.

Estimated Costs. The estimated first cost of beach restoration for shore protection by sandfill is $91,872,000.

21. NORTH SHORE OF LONG ISLAND, NASSAU COUNTY, NEW YORK

General Concepts. Beaches for recreational use are important in this area. Concepts given for reach 12 generally apply here also.

Estimated Costs. The estimated first cost of beach restoration for shore protection by sand fill is $10,692,000.

22. SHORE OF NEW YORK CITY ALONG LONG ISLAND SOUND—WESTCHESTER COUNTY TO THROGS NECK

There are no critical erosion areas in this reach.

23. WESTCHESTER COUNTY, NEW YORK, ALONG LONG ISLAND SOUND

There are no critical erosion areas in this reach.

24. CONNECTICUT (FAIRFIELD, NEW HAVEN, NEW LONDON AND MIDDLESEX COUNTIES)

General Concepts. The most needed type of improvement along this coastal area is additional protection and restoration of recreational beaches, private and public for the increasing demands for a seasonal recreational vacation and tourist trade. The most suitable type of remedial action for beach restoration is by direct placement of suitable sandfill to satisfy stability and use requirements. Stone groin structures would be used for compartmenting the beach fill if found to be economically feasible in reduction of alongshore losses of material.

In a few instances it may be more practical to provide stone revetment protection along embankments sometimes supporting massive precast concrete blocks, with a seaward recurved face for deflecting wave runup and reducing wave overtopping. Dune restoration in some areas will be necessary usually in combination with the beach restoration work.

Estimated Costs. The cost of individual improvements depends on the type and magnitude of the project and the availability of materials. The massive construction work such as rock revetment usually costs more than beach restoration work. The estimated cost of providing protection to the 25 miles of critical erosion areas along the Connecticut coast and Fisher's Island is $35,000,000.

25. RHODE ISLAND, INCLUDING BLOCK ISLAND (COUNTIES OF KINGSTON, WASHINGTON, KENT AND NEWPORT)

General Concepts. Much of the Rhode Island shorefront is developed for such recreational purposes as bathing, surfing, boating, fishing or just scenic viewing. Beach improvements along the shorefront are essential for erosion control measures and more important to meet the ever growing needs of coastal residents, summer tourists and vacationers. In most cases, protection of beach areas can be accomplished by direct placement of suitable sand fill to a width that would stabilize the shore and provide an adequate recreational area commensurate with present and future bathing requirements. In some cases it would be practical to include groin structures. In many areas such improvements as seawalls, stone revetment and bulkheads should be constructed to protect the shorefront against erosion. Dune restoration, planting and sand fencing become practical means of erosion control in some areas.

Estimated Costs. The magnitude of the improvement and availability of materials largely affects the total cost of a project. The availability of rock fill for massive protection for Block Island is a much more serious factor than for the mainland. It is estimated that the cost of protecting the 25 miles of critical eroding area for Rhode Island would amount to $30,000,000.

26. MASSACHUSETTS ELIZABETH ISLANDS, MARTHA'S VINEYARD, NANTUCKET, (DUKES COUNTY)

General Concepts. Long-range plans for the island should consider preservation of the more severely eroding beaches and backshore areas, particularly with the increasing demands for seasonal vacation living, and associated salt-water bathing.

Erosion processes of such areas at the south and east shores of the large islands of Martha's Vineyard and Nantucket Island are very complex and would require detailed studies to determine the practical and economical method of any large scale corrective measures. The most suitable type of remedial action would include beach restoration and periodic artificial placement of sandfill on the beach with and without groin structures, stone revetment for certain bluff areas and offshore breakwaters or a combination thereof. Large scale sand replenishment would likely be dependent on future sand fill obtained from carefully selected offshore areas.

Estimated Costs. The cost of providing protective improvements, constructed from massive materials, is much more expensive than similar type construction on the mainland, due to the non-availability of materials locally, requiring costly waterborne delivery and rehandling. The long-range planning needs for restoration and preservation of extensive stretches of rapidly eroding shorefront considering large scale delivery of sand for beach widening, from selected offshore sources, would be largely dependent on development of more sophisticated and economical means of sand delivery than now exists. It is estimated that the cost of protecting 60 miles of critically eroding shorefront would amount to about $75,000,000.

27. RHODE ISLAND STATE LINE TO PROVINCETOWN, MASSACHUSETTS (BRISTOL, PLYMOUTH, AND BARNSTABLE COUNTIES)

General Concepts. The need for erosion control measures along the south shore is generally in the nature of beach restoration along public or private beach areas to furnish a width of beach adequate for protection of recreational use purposes, or restoration of natural dunes and embankment or bluff protection. The erosion processes on the more exposed outer arm of Cape Cod are very complex in nature. A major beach erosion control study would be required to properly evaluate the problem and the most suitable type of remedial action.

A practical method of beach restoration is accomplished by direct placement of suitable sand fill with or without groin structures. Dune restoration can be accomplished by direct placement of fill to dimensions of the dunes found to be stable in the area, properly vegetated; with restrictions placed on the general public to a controlled access and use of the beach area to prevent indiscriminate passage over the dunes. Protection of certain embankment and bluff areas can be accomplished by such construction methods as stone mounds, stone revetments, or precast concrete blocks founded on a stone mound or bedding layer.

Estimated Costs. Provision of beach erosion control measures along 40 miles of critically eroding shorefront is estimated to cost about $50,000,000. This estimate, made in advance of detailed studies, for this very complex area susceptible to rapid losses long extensive exposed areas, considers long-range planning needs for preservation of this area. A major proportion of this erosion is experienced along the easterly exposure of the Cape Cod National Seashore.

28. PROVINCETOWN TO PEMBERTON POINT, MASSACHUSETTS (BARNSTABLE AND PLYMOUTH COUNTIES)

General Concepts. The methods of protection for the area vary in accordance with the type of problem such as exposure, the physical characteristics and geological structures of the shorefront.

Restoration of beaches may be accomplished by direct placement of suitable sand fill trucked from land sources or hydraulically pumped from suitable offshore areas sometimes in conjunction with the development of an adjacent navigation project. It may be desirable to construct groins in some locations where erosion is unusually severe.

For protection of bluff areas not receptive to beach restoration methods, protection can usually be provided by stone revetment placed along the toe of the bluffs to an elevation above the stillwater level of the most frequent storms. Either planting or light stone slope protection is sometimes appropriate above the massive base structure. Surface drainage should be controlled by some appropriate method.

Dune restoration can be provided by artificial placement of fill. The dunes should be planted with a suitable growth, usually found to be an American beach grass in New England. Controlled access through dune areas is advisable where general public use of the area is anticipated.

For some areas it is practical and economical to maintain existing structures such as bulkheads or concrete seawalls or to replace with similar structures. In all such type of construction, care should be given to protecting against erosion at the seaward base of the structure and erosion from wave overtopping along the adjacent landward side of the structure. This may be accomplished by providing adequate rock toe protection and a layer of rock topped gravel immediately behind the landward side of the seawall.

Estimated Costs. This area that experiences a variety of erosion problems varying from erosion of high bluffs and dunes endangering private cottages to extensive stretches of exposed low coastal roads or cottage developments constructed along eroding beaches, will require long range consideration of protective improvements. The cost of protecting 20 miles of the critically eroding shorefront is estimated at $30,000,000.

29. BOSTON COMPLEX — PEMBERTON POINT THROUGH BEVERLY, MASSACHUSETTS (NORFOLK, SUFFOLK, MIDDLESEX AND ESSEX COUNTIES)

General Concepts. The most suitable type of remedial action in this area would include proper land use and redevelopment cleanup and replacement of old deteriorated structures particularly in the extensive industrial and commercial inner harbor areas. Sheet pile bulkheads would be suitable within these docking areas. Utilization of a combination of stone mound and precast concrete block units would appear practical within partially protected areas along the mainland shoreline. Beach replenishment with or without groins is the most practical means of protection on natural beach shorefronts. The outer islands probably would require massive revetment along the more exposed areas with consideration given to beach development for protection and recreational use along some sectors. The protection of the outer island group is not only desirable for their preservation for recreational use but for the natural protection they afford to the mainland as a shelter from the larger storm-driven waves.

Estimated Costs. The cost estimate is based on long-range planning needs including major rehabilitation of deteriorating structures located along major harbors, restoration of large recreational use beaches, and preservation of the nearby outer islands. It is estimated that

the cost of protecting 10 miles of critically eroding shorefront would amount to about $35,000,000.

30. BEVERLY, MASSACHUSETTS TO NEW HAMPSHIRE LINE

General Concepts. Most of this section of shoreline is private recreational. Portions of the northern one-third of this region have been developed for public recreational use and are used extensively for salt water bathing. The restoration of the beach areas in this region as protective and recreational improvements is essential with the growing recreational needs of an increasing tourist and summer vacation populace. The most economical method of retarding the erosion of these beaches is by direct placement of suitable sand fill to a width and height commensurate with stability and recreational use requirements. For certain localized erosion areas where beach restoration by direct placement of sand fill would be impractical, protection could be accomplished by stone revetment, seawalls, bulkheads or a combination thereof.

Estimated Costs. The cost of providing erosion control measures along about 5 miles of critically eroding shorefront is estimated at about $10,000,000. This includes long-range planning consideration for restoration of recreational beaches, restoration of dunes and replacement of deteriorating structures.

31. NEW HAMPSHIRE (ROCKINGHAM COUNTY)

General Concepts. Most of the New Hampshire shoreline is developed for recreational use, both public and private. All usable beach areas are used extensively for salt water bathing. The restoration of beach areas as protective and recreational improvements is essential to the growing recreational needs of an increasing tourist and summer vacation populace. The method of protection for those beach areas would be accomplished by direct placement of suitable sand fill to a width and height commensurate with stability and recreational use requirements. In some cases it might be practical to include groins. For certain localized erosion problems or where beach restoration would be impractical, protection could be accomplished by stone revetment, seawalls, bulkheading or a combination thereof.

Estimated Costs. Adequate protection fronts much of the exposed State, town or private property. The cost of providing coastal protection for 2 miles of the shorefront experiencing critical erosion is estimated to cost $5,000,000. Most of the work would be for restoration of inadequate recreational beach areas.

32. NEW HAMPSHIRE STATE LINE TO KENNEBEC RIVER, MAINE (YORK, CUMBERLAND AND SAGDAHOC COUNTIES)

General Concepts. Most of the shoreline in this area is privately owned. All public use beach areas in this reach are used extensively for salt water bathing. Restoration and protection of beaches can best be accomplished by direct placement of suitable sand fill to a width and height commensurate with stability and recreational use requirements.

Estimated Costs. The State, towns and private property owners have provided substantial protection along much of the developed property. The estimated cost for providing protection along about 20 miles of shorefront experiencing critical erosion is $26,000,000. Most of this cost would be for restoration of inadequate recreational use beaches.

33. KENNEBEC RIVER, MAINE TO CANADA

There are no critical erosion areas in this reach.

TABLES

Table 1

SHORELINE CLASSIFICATION SUMMARY

(Miles of Shore)

REACHES	VIRGINIA 1	2	3	4	Total	MARYLAND 5
Physical Characteristics						
Beach	52	23	110	109	**294**	**46**
No Beach	18	156	270	255	**699**	**1,893**
Historical Shore Changes						
Critical Erosion	20	38	100	100	**258**	**180**
Non-critical Erosion	22	28	50	200	**300**	**1,500**
Non-Eroding	28	113	230	64	**435**	**259**
Shore Ownership						
Federal	25	39	15	30	**109**	**225**
Public	28	30	25	32	**115**	**35**
Private	17	110	340	302	**769**	**1,679**
Shore Use						
Public Recreation	18	10	20	2	**50**	**105**
Private Recreation	18	8	10	20	**56**	**111**
Non-recreation	21	54	50	30	**155**	**1,623**
Undeveloped	13	107	300	312	**732**	**100**
Total Length of Shore	**70**	**179**	**380**	**364**	**993**	**1,939**

REACHES	DELAWARE 6	7	8	Total	NEW JERSEY 9	10	11	12	13	Total
Physical Characteristics										
Beach	24	14	38	**76**	37	97	35	27	19	**215**
No Beach	0	106	44	**150**	48	0	205	0	1	**254**
Historical Shore Changes										
Critical Erosion	24	2	2	**28**	5	74	10	27	6	**122**
Non-critical Erosion	0	0	31	**31**	26	12	63	0	9	**110**
Non-Eroding	0	118	49	**167**	54	11	167	0	5	**237**
Shore Ownership										
Federal	1	0	11	**12**	23	8	30	6	0	**67**
Public	17	15	14	**46**	19	66	27	11	7	**130**
Private	6	105	57	**168**	43	23	183	10	13	**272**
Shore Use										
Public Recreation	21	3	9	**33**	61	88	119	14	8	**290**
Private Recreation	2	32	0	**34**	0	0	23	10	2	**35**
Non-recreation	1	0	2	**3**	2	0	1	0	9	**12**
Undeveloped	0	85	71	**156**	22	9	97	3	1	**132**
Total Length of Shore	**24**	**120**	**82**	**226**	**85**	**97**	**240**	**27**	**20**	**469**

Table 1

SHORELINE CLASSIFICATION SUMMARY

(Miles of Shore)

REACHES	NEW YORK										
	14	15	16	17	18	19	20	21	22	23	Totals
Physical Characteristics											
Beach	12	3	10	108	7	88	80	10	9	4	**331**
No Beach	1	2	0	0	165	80	7	6	9	37	**307**
Historical Shore Changes											
Critical Erosion	7	3	10	108	0	75	87	9	0	0	**299**
Non-critical Erosion	6	2	0	0	172	93	0	7	18	41	**339**
Non-Eroding	0	0	0	0	0	0	0	0	0	0	**0**
Shore Ownership											
Federal	0	0	1	14	15	4	0	0	0	0	**34**
Public	9	3	7	36	67	40	16	4	11	9	**202**
Private	4	2	2	58	90	124	71	12	7	32	**402**
Shore Use											
Public Recreation	7	3	7	50	77	32	16	3	7	8	**210**
Private Recreation	1	1	2	8	25	9	16	0	2	6	**70**
Non-recreation	5	1	1	33	26	94	44	10	9	27	**250**
Undeveloped	0	0	0	17	44	33	11	3	0	0	**108**
Total Length of Shore	**13**	**5**	**10**	**108**	**172**	**168**	**87**	**16**	**18**	**41**	**638**

REACHES	CONN.	R.I.	MASSACHUSETTS					
	24	25	26	27	28	29	30	Total
Physical Characteristics								
Beach	**145**	**185**	230	370	165	100	75	**940**
No Beach	**125**	**155**	70	70	35	50	35	**260**
Historical Shore Changes								
Critical Erosion	**25**	**25**	60	40	20	10	5	**135**
Non-critical Erosion	**240**	**310**	230	390	165	140	105	**1030**
Non-Eroding	**5**	**5**	10	10	15	0	0	**35**
Shore Ownership								
Federal	**5**	**10**	5	50	15	10	10	**90**
Public	**50**	**50**	50	50	30	30	15	**175**
Private	**215**	**280**	245	340	155	110	85	**935**
Shore Use								
Public Recreation	**30**	**50**	50	90	50	25	20	**235**
Private Recreation	**225**	**270**	170	335	145	80	70	**800**
Non-recreation	**15**	**20**	10	15	5	35	20	**85**
Undeveloped	**0**	**0**	70	0	0	10	0	**80**
Total Length of Shore	**270**	**340**	**300**	**440**	**200**	**150**	**110**	**1200**

Table 1

SHORELINE CLASSIFICATION SUMMARY
(Miles of Shore)

REACHES	N.H.	MAINE			TOTAL LENGTH OF SHORELINE REACHES 1-33
	31	32	33	Total	
Physical Characteristics					
Beach	25	50	10	60	2,317
No Beach	15	550	1,890	2,440	6,298
Historical Shore Changes					
Critical Erosion	2	20	0	20	1,094
Non-critical Erosion	36	575	1,900	2,475	8,371 6,371
Non-Eroding	2	5	0	5	1,150
Shore Ownership					
Federal	2	10	10	20	574
Public	10	50	10	60	873
Private	28	540	1,880	2,420	7,168
Shore Use					
Public Recreation	8	8	5	13	1,024
Private Recreation	30	522	445	967	2,598
Non-recreation	2	10	250	260	2,425
Undeveloped	0	60	1,200	1,260	2,568
Total Length of Shore	40	600	1,900	2,500	8,615

Table 2

SUMMARY OF GENERAL POLICY OF STATE PARTICIPATION IN SHORE PROTECTION PROJECTS

State Participation—Portion of Non-Federal Share	
	Federal Projects
100%	Delaware (Each project must be approved individually by the State Legislature)
50%	Massachusetts, Connecticut
70%	New York
75%	New Jersey
a/	Maryland
No specific programs	Virginia, Rhode Island, Maine, New Hampshire
	Other Projects
100%	Delaware (Each project must be approved individually by the State Legislature)
67% b/	Connecticut
50%	Massachusetts, Rhode Island
75%	New Jersey
70%	New York
a/	Maryland
No specific programs	Virginia, Maine, New Hampshire

a/Interest-free loans to municipalities made by State of Maryland.
b/For publicly owned shores. For privately-owned shores the State pays one-third.

Table 3

CONCEPTUAL IMPROVEMENT METHODS FOR CRITICAL EROSION AREAS AND APPROXIMATE FIRST COSTS

Location	Type of Improvement	Cost of Improvement ($)	Length of shore where erosion is considered critical (miles)
Virginia			
Virginia-Carolina line to Isle of Wight County line	Sand fill and bulkheading	31,600,000	20
Shores of York, James, Rappahannock and Potomac Rivers	Sand fill, bulkheading and groins	31,900,000	138
Eastern Shore and Barrier Islands of Virginia	Sand fences, revetment	26,000,000	100
Maryland			
Anne Arundel County	Sand fill, bulkheading, groins, revetment	4,000,000	8
Baltimore County	do	2,700,000	5
Calvert County	do	3,200,000	6
Charles County	Sand fill, bulkheading, groins, revetment	500,000	1
Harford County	do	500,000	1
St. Mary's County	do	20,200,000	38
Cecil County	do	1,600,000	3
Dorchester County	do	11,000,000	21
Kent County	do	3,700,000	7
Queen Anne's County	do	8,100,000	15
Somerset County	do	6,900,000	13
Talbot County	do	17,000,000	32
Ocean City	Sand fill	9,800,000	8
Assateague Island	Sand fill	14,500,000	22
Delaware			
Cape Henlopen to Indian River Inlet	Sand fill, bulkheading, dune grass, sand fence	7,100,000	14
Indian River Inlet to Fenwick Island	Sand fill, bulkheading, dune grass	3,800,000	10
Rehoboth, Indian River and Little Assawoman Bays	Bulkheading, revetment	1,130,000	2
Delaware River and Bay Shore of Delaware	Beach fill, sand fences, dune grass	282,000	2

Table 3

CONCEPTUAL IMPROVEMENT METHODS FOR CRITICAL EROSION AREAS AND APPROXIMATE FIRST COSTS

Location	Type of Improvement	Cost of Improvement ($)	Length of shore where erosion is considered critical (miles)
New Jersey			
Delaware River and Bay Shore	Beach fill, bulkheading	1,573,000	5
Manasquan Inlet to Cape May Point	Sand fill, bulkheading, groins	84,000,000	74
Barnaget Bay to Cape May Harbor	Sand fill, revetment, bulkheading	4,300,000	10
Sandy Hook to Manasquan Inlet	Sand fill, bulkheading	48,960,000	27
Raritan Bay and Sandy Hook Bay	Sand fill, bulkheading	2,300,000	6
New York			
Fort Wadsworth to Arthur Kill	Sand fill	3,084,000	7
Rockaway Inlet to Norton Point	Sand fill	1,394,000	3
East Rockaway Inlet to Rockaway Inlet	Sand fill	5,280,000	10
South Shore of Long Island	Sand fill	156,816,000	108
Eastern Forks of Long Island	Sand fill	59,400,000	75
North Shore of Long Island Suffolk County	Sand fill	91,872,000	87
North Shore of Long Island, Nassau County	Sand fill	10,692,000	9
Connecticut	Sand fill, revetments, bulkheading	35,000,000	25
Rhode Island	Sand fill, groins, rock revetment	30,000,000	25
Massachusetts			
Elizabeth Islands, Martha's Vineyard Nantucket	Sand fill	75,000,000	60
Rhode Island State line to Provincetown	Sand fill, revetments	50,000,000	40
Provincetown to Pemberton Point	do	30,000,000	20
Boston Complex	do	35,000,000	10
Beverly to New Hampshire State line	do	10,000,000	5
New Hampshire	Sand fill	5,000,000	2
Maine			
New Hampshire State line to Kennebec River	Sand fill, revetments	26,000,000	20

Table 4

FEDERALLY AUTHORIZED COASTAL PROTECTION PROJECTS

(IN STATE OF VIRGINIA)

Project	Estimated First Cost* Total ($)	Estimated First Cost* Federal ($)	Shore Protected (miles)	Periodic Sand Replacement: Estimated Annual Cost Total ($)	Periodic Sand Replacement: Estimated Annual Cost Federal ($)	Periodic Sand Replacement: Federal Participation (yrs.)
Completed BEC Projects						
Virginia Beach	705,300**	229,600	3.3	142,000	70,800	25
BEC Projects Under Construction						
None						
Active BEC Projects Not Started						
None						
Inactive or Deferred BEC Projects Not Started						
Colonial Beach, Westmoreland County	225,000	75,000	1.4	—	—	—
Completed Multi-Purpose Projects Which Include BEC						
None						
Multi-Purpose Projects Which Include BEC, Under Construction						
None						
Active Multi-Purpose Projects Which Include BEC Not Started						
None						
Inactive or Deferred Multi-Purpose Projects Which Include BEC, Not Started						
None						

* Excludes periodic sand replacement.
**Excludes groin construction which is in deferred status.
BEC: Beach Erosion Control

Table 4

FEDERALLY AUTHORIZED COASTAL PROTECTION PROJECTS

(IN STATE OF MARYLAND)

Project	Estimated First Cost* Total ($)	Estimated First Cost* Federal ($)	Shore Protected (miles)	Periodic Sand Replacement: Estimated Annual Cost Total ($)	Periodic Sand Replacement: Estimated Annual Cost Federal ($)	Periodic Sand Replacement: Federal Participation (yrs.)
Completed BEC Projects						
None						
BEC Projects Under Construction						
Oxford, Talbot County	176,500	88,250	0.2	—	—	—
Active BEC Projects Not Started						
None						
Inactive or Deferred BEC Projects Not Started						
None						
Completed Multi-Purpose Projects Which Include BEC						
None						
Multi-Purpose Projects Which Include BEC Under Construction						
None						
Active Multi-Purpose Projects Which Include BEC Not Started						
None						
Inactive or Deferred Multi-Purpose Projects Which Include BEC, Not Started						
None						

* Excludes periodic sand replacement.
BEC: Beach Erosion Control

Table 4

FEDERALLY AUTHORIZED COASTAL PROTECTION PROJECTS

(IN STATE OF DELAWARE)

Project	Estimated First Cost* Total ($)	Estimated First Cost* Federal ($)	Shore Protected (miles)	Periodic Sand Replacement: Estimated Annual Cost Total ($)	Periodic Sand Replacement: Estimated Annual Cost Federal ($)	Periodic Sand Replacement: Federal Participation (yrs.)
Completed BEC Projects						
None						
BEC Projects Under Construction						
None						
Active BEC Projects Not Started						
None						
Inactive or Deferred BEC Projects Not Started						
None						
Completed Multi-Purpose Projects Which Include BEC						
None						
Multi-Purpose Projects Which Include BEC Under Construction						
None						
Active Multi-Purpose Projects Which Include BEC Not Started						
Coast of Delaware	10,900,000	7,565,000	24.5	1,171,000	205,000	50
Inactive or Deferred Multi-Purpose Projects Which Include BEC, Not Started						
None						

* Excludes periodic sand replacement.
BEC: Beach Erosion Control

Table 4

FEDERALLY AUTHORIZED COASTAL PROTECTION PROJECTS
(IN STATE OF NEW JERSEY)

Project	Estimated First Cost* Total ($)	Estimated First Cost* Federal ($)	Shore Protected (miles)	Periodic Sand Replacement: Estimated Annual Cost Total ($)	Periodic Sand Replacement: Estimated Annual Cost Federal ($)	Periodic Sand Replacement: Federal Participation (yrs.)
Completed BEC Projects						
None						
BEC Projects Under Construction						
Perth Amboy	164,000	82,000	0.1	—	—	—
Cape May City	1,685,000	761,000	2.8	84,000	39,000	10
Atlantic City	6,740,000	2,805,000	1.8	301,000	151,000	10
Total	8,589,000	3,648,000	4.7	385,000	190,000	
Active BEC Projects Not Started						
Atlantic Coast, Sandy Hook to Barnegat Inlet	39,910,000	14,055,000	36	1,504,000	659,000	10
Five Mile Beach	37,000	18,000	0.8	23,000	11,000	10
Ventnor, Margate, Longport	204,000	98,000	1	51,000	24,000	10
Total	40,151,000	14,171,000	37.8	1,578,000	694,000	
Inactive or Deferred BEC Projects Not Started						
Barnegat Light	368,000	147,000	0.2	10,000	6,000	10
Long Beach Island	978,000	462,000	2.5	672,000	310,000	10
Total	1,346,000	609,000	2.7	682,000	316,000	
Completed Multi-Purpose Projects Which Include BEC						
None						
Multi-Purpose Projects Which Include BEC Under Construction						
Raritan Bay and Sandy Hook Bay	12,000,000	7,790,000	7	—	—	—
Total	12,000,000	7,790,000	7	—	—	—
Active Multi-Purpose Projects Which Include BEC Not Started						
Great Egg Harbor Inlet and Peck Beach	11,300,000	5,639,000	8	515,000	257,000	50
Corson Inlet and Ludlam Beach	10,700,000	4,986,000	7	520,000	242,000	50
Townsend Inlet and 7-mile Beach	8,000,000	3,976,000	7	636,000	316,000	50
Total	30,000,000	14,601,000	22	1,671,000	815,000	
Inactive or Deferred Multi-Purpose Projects Which Include BEC, Not Started						
None						

* Excludes periodic sand replacement.
BEC: Beach Erosion Control

Table 4

FEDERALLY AUTHORIZED COASTAL PROTECTION PROJECTS

(IN STATE OF NEW YORK)

Project	Estimated First Cost* Total ($)	Estimated First Cost* Federal ($)	Shore Protected (miles)	Periodic Sand Replacement: Estimated Annual Cost Total ($)	Periodic Sand Replacement: Estimated Annual Cost Federal ($)	Periodic Sand Replacement: Federal Participation (yrs.)
Completed BEC Projects						
None						
BEC Projects Under Construction						
None						
Active BEC Projects Not Started						
None						
Inactive or Deferred BEC Projects Not Started						
None						
Completed Multi-Purpose Projects Which Include BEC						
None						
Multi-Purpose Projects Which Include BEC Under Construction						
Fire Island Inlet to Montauk Point	80,350,000	42,280,000	71	512,000	44,000	10
Fire Island Inlet to Jones Inlet	21,113,000	13,940,000	5	—	—	—
Total	101,463,000	56,220,000	76	512,000	44,000	
Active Multi-Purpose Projects Which Include BEC Not Started						
East Rockaway Inlet to Rockaway Inlet and Jamaica Bay	70,200,000	43,470,000*	10	752,000	318,000	10
Ft. Wadsworth to Arthur Kill	16,860,000	11,240,000	7.3	234,000	94,000	10
Total	78,060,000	54,710,000	17.3	986,000	412,000	
Inactive or Deferred Multi-Purpose Projects Which Include BEC, Not Started						
None						

* Excludes periodic sand replacement.
BEC: Beach Erosion Control

Table 4

FEDERALLY AUTHORIZED COASTAL PROTECTION PROJECTS (IN STATE OF CONNECTICUT)

Project	Estimated First Cost* Total ($)	Estimated First Cost* Federal ($)	Shore Protected (miles)	Periodic Sand Replacement: Estimated Annual Cost Total ($)	Periodic Sand Replacement: Estimated Annual Cost Federal ($)	Periodic Sand Replacement: Federal Participation (yrs.)
Completed BEC Projects						
Cummings Park	80,500	27,000	0.2	—	—	—
Cove Island	141,500	47,000	0.25	—	—	—
Calf Pasture	176,500	56,500	0.4	—	—	—
Compo Beach	253,500	84,500	0.7	—	—	—
Sherwood Island	560,000	187,000	1.15	—	—	—
Burial Hill	17,500	6,000	0.1	—	—	—
Southport	53,000	17,500	0.15	—	—	—
Sasco Hill	71,500	24,000	0.15	—	—	—
Seaside Park	480,000	150,000	1.7	—	—	—
Short Beach	None**	None	0.5	—	—	—
Gulf	64,000	21,500	0.25	—	—	—
Woodmont	161,500	54,000	0.8	—	—	—
Prospect	241,000	104,500	1.15	—	—	—
Middle	26,500	9,000	0.15	—	—	—
Hammonasset Beach State Park	490,000	163,000	1.85	—	—	—
Jennings Beach & Ash Creek	43,000	14,500	0.35	—	—	—
Silver & Cedar Beach	335,000	62,500	3	—	—	—
Guilford Beach	47,000	15,500	0.1	—	—	—
Lighthouse Point	12,000	4,000	0.15	—	—	—
Total	3,254,000	1,048,000	13.1	—	—	—
BEC Projects Under Construction						
None						
Active BEC Projects Not Started						
Greenwich Point Park	376,000	188,000	0.5	—	—	—
Total	376,000	188,000	0.5	—	—	—
Inactive or Deferred BEC Projects Not Started						
None						
Completed Multi-Purpose Projects Which Include BEC						
None						
Multi-Purpose Projects Which Include BEC, Under Construction						
None						
Active Multi-Purpose Projects Which Include BEC Not Started						
None						
Inactive or Deferred Multi-Purpose Projects Which Include BEC, Not Started						
None						

* Excludes periodic sand replacement.
**Project completed by placement of sand dredged under Housatonic River navigation project
BEC: Beach Erosion Control

Table 4

FEDERALLY AUTHORIZED COASTAL PROTECTION PROJECTS

(IN STATE OF RHODE ISLAND)

Project	Estimated First Cost* Total ($)	Estimated First Cost* Federal ($)	Shore Protected (miles)	Periodic Sand Replacement: Estimated Annual Cost Total ($)	Periodic Sand Replacement: Estimated Annual Cost Federal ($)	Periodic Sand Replacement: Federal Participation (yrs.)
Completed BEC Projects						
Misquamicut Beach	43,500	14,500	0.6	—	—	—
Sand Hill Cove	120,500	40,000	1	—	—	—
Total	164,000	54,500	1.6	—	—	—
BEC Projects Under Construction						
Cliff Walk	1,230,000	280,000	3.4	—	—	—
Active BEC Projects Not Started						
Narragansett Pier	1,255,000	415,000	1.0	—	—	—
Matunuck Beach	520,000	260,000	0.7	—	—	—
Total	1,775,000	675,000	1.7	—	—	—
Inactive or Deferred BEC Projects Not Started						
Napatree Beach	186,000	62,000	0.4	—	—	—
Completed Multi-Purpose Projects Which Include BEC						
None						
Multi-Purpose Projects Which Include BEC Under Construction						
None						
Active Multi-Purpose Projects Which Include BEC Not Started						
Westerly	7,440,000	4,900,000	5	—	—	—
Inactive or Deferred Multi-Purpose Projects Which Include BEC, Not Started						
Point Judith	7,100,000	5,000,000	3.5	—	—	—
Narragansett Pier	4,100,000	2,500,000	2	—	—	—
Total	11,200,000	7,500,000	5.5	—	—	—

* Excludes periodic sand replacement.
BEC: Beach Erosion Control

Table 4

FEDERALLY AUTHORIZED COASTAL PROTECTION PROJECTS

(IN STATE OF MASSACHUSETTS)

Project	Estimated First Cost* Total ($)	Estimated First Cost* Federal ($)	Shore Protected (miles)	Periodic Sand Replacement: Estimated Annual Cost Total ($)	Periodic Sand Replacement: Estimated Annual Cost Federal ($)	Periodic Sand Replacement: Federal Participation (yrs.)
Completed BEC Projects						
N. Scituate	213,000	106,500	0.5	10,000	5,000	10
Wessagussett	381,000	181,000	0.5	—	—	—
Quincy Shore	1,864,500	621,500	1.6	—	—	—
Plymouth Town	16,500	5,500	0.25	—	—	—
Winthrop	874,000	349,000	0.65	—	—	—
Total	3,367,000	1,263,500	3.50	10,000	5,000	
BEC Projects Under Construction						
None						
Active BEC Projects Not Started						
Clark Pt.	344,000	172,000	0.3	—	—	—
Oak Bluff	400,000	230,000	0.25	—	—	—
Provincetown	1,034,000	724,000	0.3	—	—	—
Thumpertown	196,000	98,000	0.3	—	—	—
Town Neck	511,000	273,000	1.3	20,000	10,000**	10**
Brant Rock	332,000	166,000	0.5	—	—	—
Nantasket	2,240,000	1,120,000	1.3	50,000	25,000	10
Revere	2,680,000	1,340,000	2.6	50,000	25,000	10
Lynn-Nahant	925,000	584,000	1.65	—	—	—
Total	8,662,000	4,707,000	8.5	120,000	60,000	
Inactive or Deferred BEC Projects Not Started						
None						
Completed Multi-Purpose Projects Which Include BEC						
None						
Multi-Purpose Projects Which Include BEC, Under Construction						
None						
Active Multi-Purpose Projects Which Include BEC Not Started						
None						
Inactive or Deferred Multi-Purpose Projects Which Include BEC, Not Started						
None						

* Excludes periodic sand replacement.
**Construction of groins by State precludes further Federal praticipation.
BEC: Beach Erosion Control

Table 4

FEDERALLY AUTHORIZED COASTAL PROTECTION PROJECTS

(IN STATE OF NEW HAMPSHIRE)

Project	Estimated First Cost* Total ($)	Estimated First Cost* Federal ($)	Shore Protected (miles)	Periodic Sand Replacement: Estimated Annual Cost Total ($)	Periodic Sand Replacement: Estimated Annual Cost Federal ($)	Periodic Sand Replacement: Federal Participation (yrs.)
Completed BEC Projects						
Hampton Beach	646,500	261,000	1	110,000	55,000	10
Wallis Sands	93,000	65,000	0.2	—	—	—
Total	739,500	326,000	1.2	110,000	55,000	
BEC Projects Under Construction						
None						
Active BEC Projects Not Started						
N. Hampton Beach	291,000	103,000	0.2	—	—	—
Total	291,000	103,000	0.2	—	—	—
Inactive or Deferred BEC Projects Not Started						
None						
Completed Multi-Purpose Projects Which Include BEC						
None						
Multi-Purpose Projects Which Include BEC Under Construction						
None						
Active Multi-Purpose Projects Which Include BEC Not Started						
None						
Inactive or Deferred Multi-Purpose Projects Which Include BEC, Not Started						
None						

* Excludes periodic sand replacement.
BEC: Beach Erosion Control

Table 4

FEDERALLY AUTHORIZED COASTAL PROTECTION PROJECTS

(IN STATE OF MAINE)

Project	Estimated First Cost* Total ($)	Estimated First Cost* Federal ($)	Shore Protected (miles)	Periodic Sand Replacement: Estimated Annual Cost Total ($)	Periodic Sand Replacement: Estimated Annual Cost Federal ($)	Periodic Sand Replacement: Federal Participation (yrs.)
Completed BEC Projects						
None						
BEC Projects Under Construction						
None						
Active BEC Projects Not Started						
None						
Inactive or Deferred BEC Projects Not Started						
None						
Completed Multi-Purpose Projects Which Include BEC						
None						
Multi-Purpose Projects Which Include BEC Under Construction						
None						
Active Multi-Purpose Projects Which Include BEC Not Started						
None						
Inactive or Deferred Multi-Purpose Projects Which Include BEC, Not Started						
None						

* Excludes periodic sand replacement.
BEC: Beach Erosion Control

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BIBLIOGRAPHY OF FEDERAL STUDIES

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to East River, Connecticut, Beach Erosion Control Study," February 1950.

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11. House Document No. 146, 89th Congress, 1st Session, "Connecticut Coastal and Tidal Areas," April 1965.

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10. House Document No. 764, 80th Congress, 2nd Session, "Winthrop Beach, Massachusetts, Beach Erosion Control Study," December 1948.
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National Seashore

National Shoreline Study

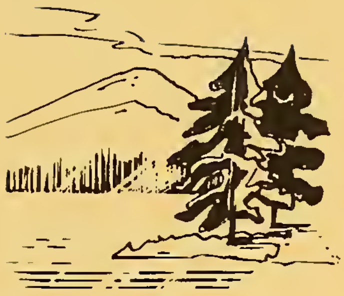
Plate 57 to 64

Regional Inventory Report

NORTH ATLANTIC REGION

Volume II

U.S. Army Engineer Division, No. Atlantic
Corps of Engineers
New York, N.Y. 10007
1971



The National Shoreline Study

How will the shore be used ?

SEE

SHORE MANAGEMENT GUIDELINES

What is its condition ?

SEE

REGIONAL INVENTORY REPORTS

What can be done ?

to preserve or enhance the shore,
by using–

- Engineering techniques

SEE

SHORE PROTECTION GUIDELINES
REGIONAL INVENTORY REPORTS

- Management techniques

SEE

SHORE MANAGEMENT GUIDELINES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RAPPAHANNOCK RIVER
YORK RIVER
JAMES RIVER
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ATLANTIC OCEAN
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LIST OF CAPTIONS—VIRGINIA

V- 1	Virginia Beach, Va.—1970
V- 2	Virginia Beach, Va.—1970
V- 3	Ocean View, Va.—1970
V- 4	Willoughby Spit, Va.—1970
V- 5	Norfolk, Va.—1970
V- 6	Newport News, Va.—1970
V- 7	Buckroe Beach, Va.—1970
V- 8	Gloucester Point, Va.—1970
V- 9	New Point Comfort, Va.—1970
V-10	Gwynn Island, Va.—1970
V-11	Weems, Va.—1970
V-12	Lancaster County, Va.—1970
V-13	Northumberland, Va.—1970
V-14	Onancock, Va.—1970
V-15	Silver Beach, Va.—1970
V-16	Fisherman Island, Va.—1970
V-17	Eastern Shore, Va.—1970
V-18	Eastern Shore, Va.—1970

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LIST OF CAPTIONS—MARYLAND

MD- 1	Love Point, Queen Annes Co., Maryland.
MD- 2	Kent Island shoreline along Chesapeake Bay, Queen Annes Co.
MD- 3	Thomas Pt., Anne Arundel Co., Maryland.
MD- 4	Thomas Pt., Anne Arundel Co., Maryland.
MD- 5	Chesapeake Bay shoreline near Chesapeake Beach, Calvert Co.
MD- 6	Chesapeake Bay shoreline along Calverts Cliffs, Calvert Co.
MD- 7	Chesapeake Bay shoreline along Patuxent NAS, St. Mary's Co., Maryland.
MD- 8	South Taylors Island on Chesapeake Bay, Dorchester Co.
MD- 9	South Taylors Island on Chesapeake Bay, Dorchester Co.
MD-10	Chesapeake Bay shoreline along St. Mary's Co., Maryland.
MD-11	St. Georges Island, St. Marys Co.
MD-12	St. Georges Island, St. Marys Co.
MD-13	Point Lookout State Park (Chesapeake Bay), St. Mary's Co.
MD-14	St. Clements Island (west side), St. Mary's Co.
MD-15	St. Clements Island (west side), St. Mary's Co.
MD-16	View of Ocean City—looking north of 21st St.
MD-17	View of Ocena City—looking south of 18th St.
MD-18	Storm damage to Ocean City Inlet
MD-19	Beach on Assateague Island, one mile south of Ocean City Inlet.

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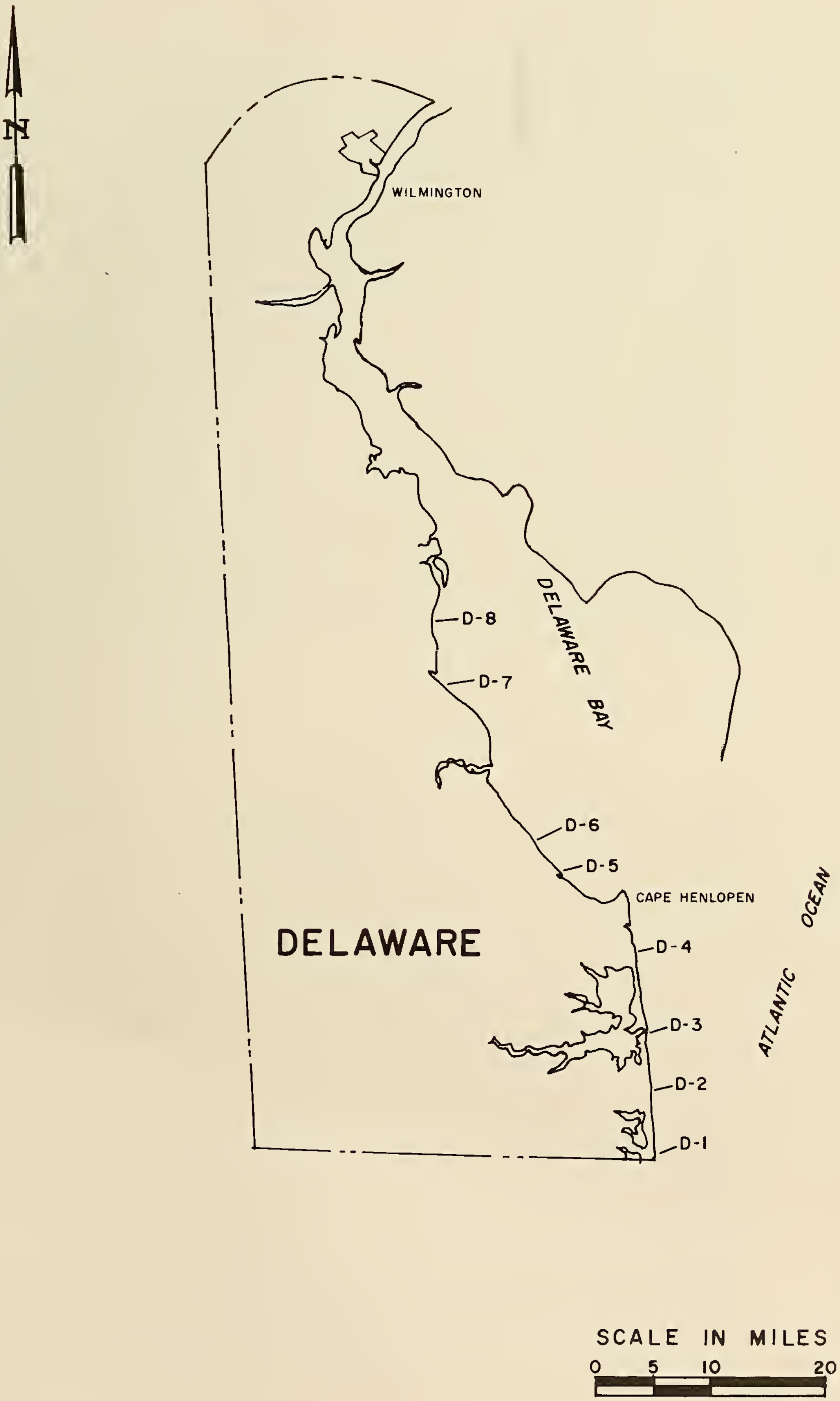
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LIST OF CAPTIONS—DELAWARE

D-1 Fenwick Island, Delaware—Southern end of Delaware—1964.

D-2 Bethany Beach, Delaware—View shows beach, three groins and portion of boardwalk—1964.

D-3 Indian River Inlet, Delaware—View shows jetties, beaches and developed areas on both sides of jetties—1964.

D-4 Rehoboth Beach, Delaware—showing border (long curved road) between Rehoboth Beach and Henlopen Acres, and beaches at both locations—1964.

D-5 Broadkill Beach, Delaware—View shows four groins and summer resort—1964.

D-6 Primehook Beach (Shorts Beach), Delaware—View of beach and community at Bay end of access road—1964.

D-7 Bowers, Delaware—View of Murderkill River, and community of Bowers located at its mouth—looking south—1964.

D-8 Pickering Beach, Delaware—View of beach and a developed area, and access road to this community—looking south—1964.

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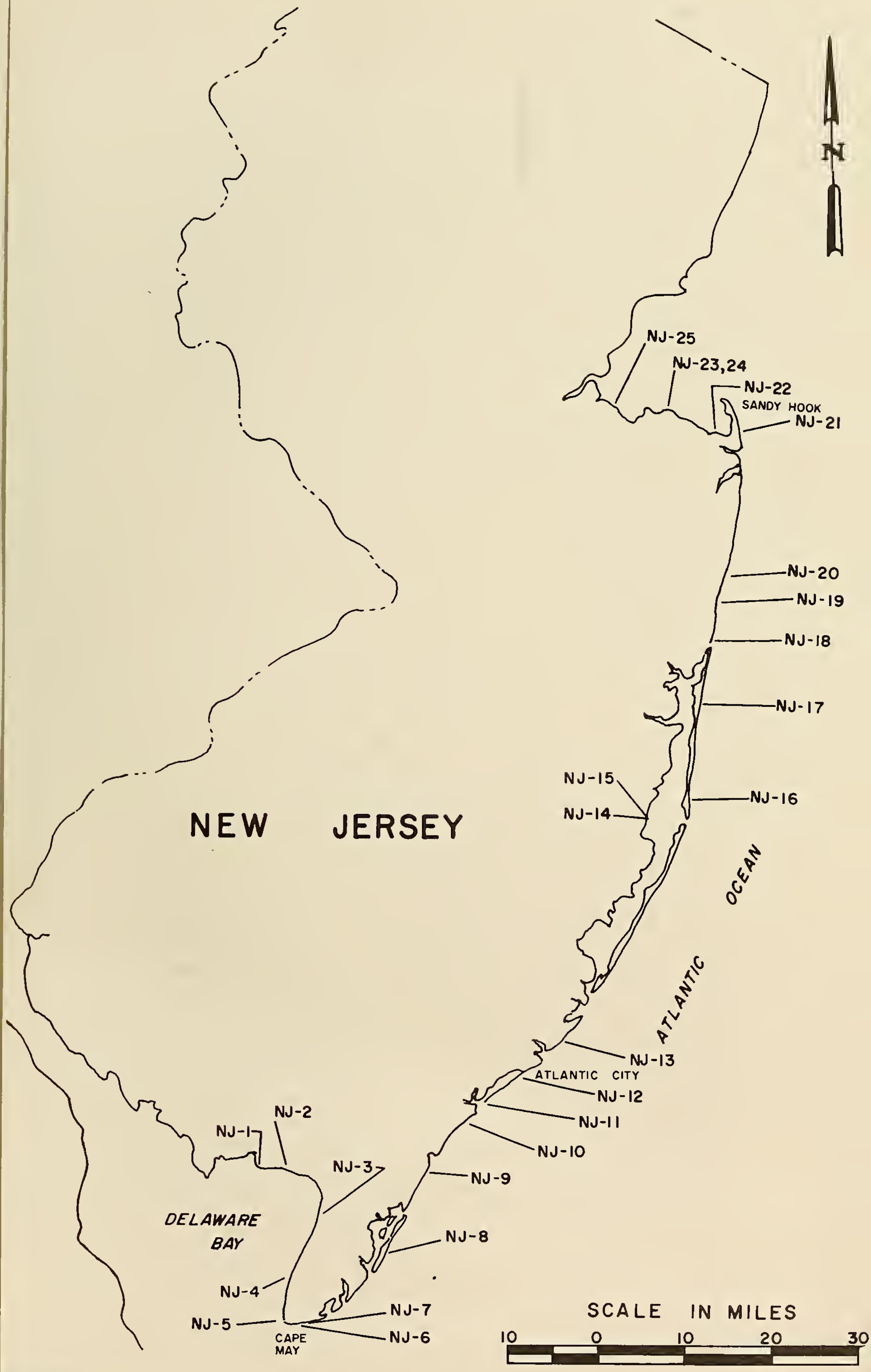
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LIST OF CAPTIONS—NEW JERSEY

NJ- 1 Thompson's Beach, N. J.—Looking southeast—1955.

NJ- 2 Moores Beach, N. J.—Looking southeast—1950.

NJ- 3 Reeds Beach, N. J.—From boatyard looking south—1955.

NJ- 4 Wildwood Villas, N. J.—Looking North from north end—1955.

NJ- 5 Cape May Point, N.J.—Looking north from Cape May Avenue—1967.

NJ- 6 Lower Township, N. J.—Looking northwest from 2nd Avenue, Cape May, N. J.—1967.

NJ- 7 Cape May City, N. J.—Looking west from Pittsburg Ave.—1967.

NJ- 8 Stone Harbor, N. J. at 94th St.—Looking west—1964.

NJ- 9 Strathmere, N. J. at Seaview Avenue—Looking west—1964.

NJ-10 Ocean City N. J. at 3rd St.—Looking west—1964.

NJ-11 Longport, N. J.—1968.

NJ-12 Ventnor, N. J.—1968.

NJ-13 Brigantine, N. J.—1968.

NJ-14 Looking south to Double Creek Jetty, N. J.—1965.

NJ-15 Looking north from Double Creek Jetty, N. J.—1965.

NJ-16 Holgate, N. J.—1968.

NJ-17 Lavallette, N. J.—1968.

NJ-18 Bay Head, N. J.—1968.

NJ-19 Manasquan Inlet

NJ-20 Avon and Belmar

NJ-21 Highlands and Sandy Hook—1969.

NJ-22 Highlands—1969.

NJ-23 Keansburg, N.J.—after improvement—1969.

NJ-24 Residential area at Keansburg, N. J.—Amusement area in foreground—1960.

NJ-25 Madison Township, N. J.—1970.

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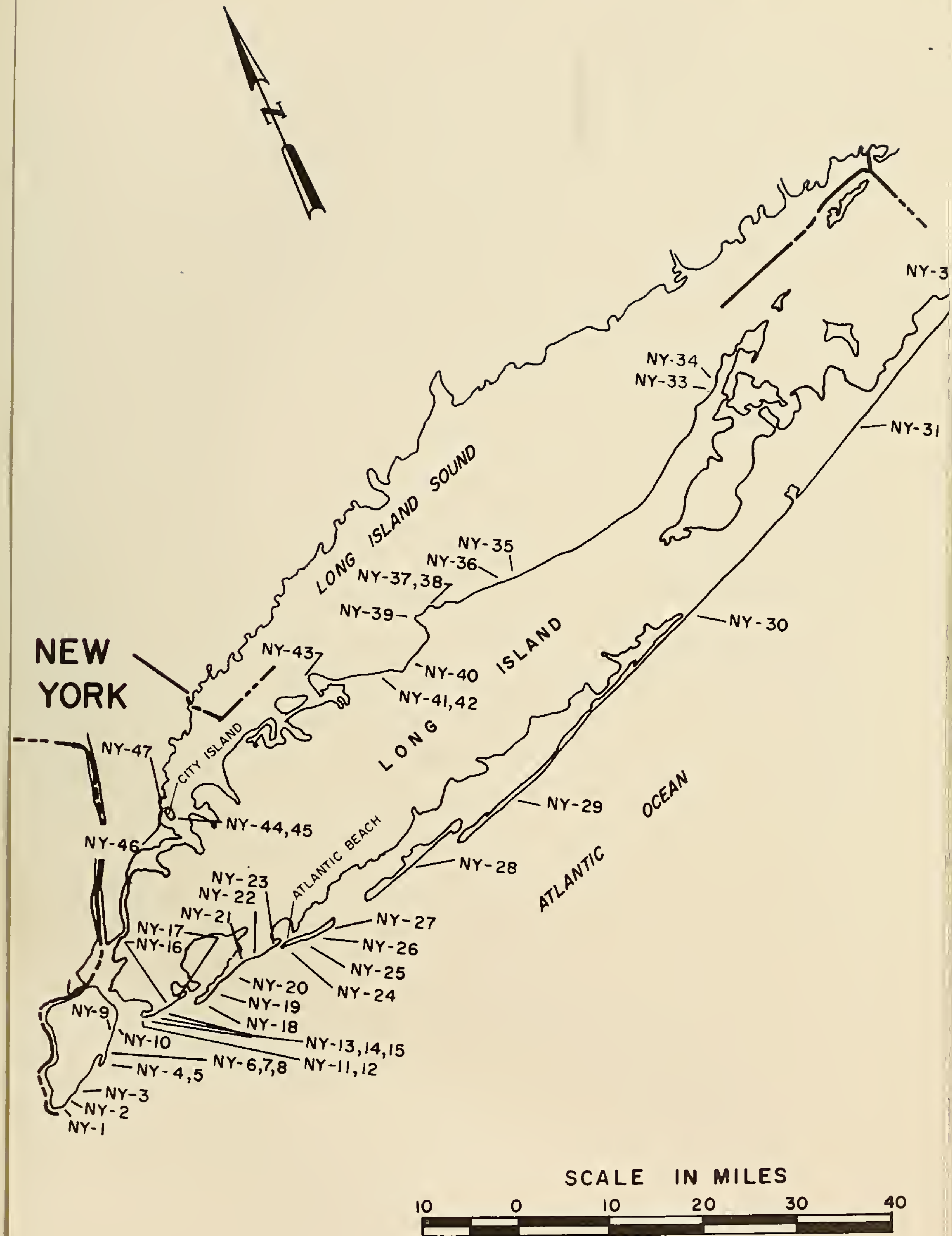
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NY-47
SCALE IN MILES
10 0 10 20 30 40

LIST OF CAPTIONS—NEW YORK

NY- 1 Bank erosion at Anderson Beach, Princess Bay—1952.

NY- 2 Bank erosion at Huguenot Beach—1951.

NY- 3 Bank erosion at Annandale Beach—1954.

NY- 4 Break through in temporary dike, Oakwood Beach—1954.

NY- 5 Sand dike at Oakwood Beach—1963.

NY- 6 Cedar Grove Beach and New Dorp Beach—1962.

NY- 7 Cedar Grove Beach and New Dorp Beach—1962.

NY- 8 New Dorp Beach—1963.

NY- 9 Western end of South Beach in the Midland and Woodland Beach area—1963.

NY-10 Western section of South Beach in the Graham Beach area—1963.

NY-11 Sea Gate—View to the east—1968.

NY-12 Sea Gate—1966.

NY-13 Coney Island & Coney Island Beach View to the east—1968.

NY-14 Brighton Beach at end of Coney Island Beach—1966.

NY-15 Coney Island Beach—View to the west—1966.

NY-16 Manhattan Beach Esplanade, note destroyed western portion—1966.

NY-17 Manhattan Beach Park—1966.

NY-18 Jacob Riis Park

NY-19 Rockaway Beach

NY-20 Arverne

NY-21 Arverne

NY-22 Flooded bay shore front Arverne

NY-23 Far Rockaway

NY-24 Atlantic Beach

NY-25 Long Beach

LIST OF CAPTIONS—NEW YORK (Continued)

NY-26	Long Beach
NY-27	Long Beach
NY-28	Gilgo Beach
NY-29	Point O'Woods
NY-30	Westhampton Beach
NY-31	East Hampton
NY-32	Montauk Point—1966.
NY-33	Hashomomuck Beach—1966
NY-34	Arshamonague Shore—1966
NY-35	Rocky Point—1964.
NY-36	Woodhull Landing—1967.
NY-37	Old Field Point and shore eastward—1966.
NY-38	Old Field Point and shore westward—1966.
NY-39	Crane Neck Point, Old Field
NY-40	Shore Bluffs at Nissequogue—1966.
NY-41	Sunken Meadow State Park—eastward view—1966.
NY-42	Sunken Meadow State Park—eastward view—1967.
NY-43	Valley Grove Area—west shore of Eatons Neck—1966.
NY-44	City Island—looking northward
NY-45	City Island—looking northward
NY-46	Rodman Neck—looking northward
NY-47	Pelham Bay Park

NY-1

NY-2

NY-3

NY-4

NY-5

NY-6

NY-7

NY-8

NY-9

NY-10

NY-11

NY-12

NY-13

NY-14

NY-15

NY-16

NY-17

NY-18

NY-19

NY-20

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NY-22

NY-23

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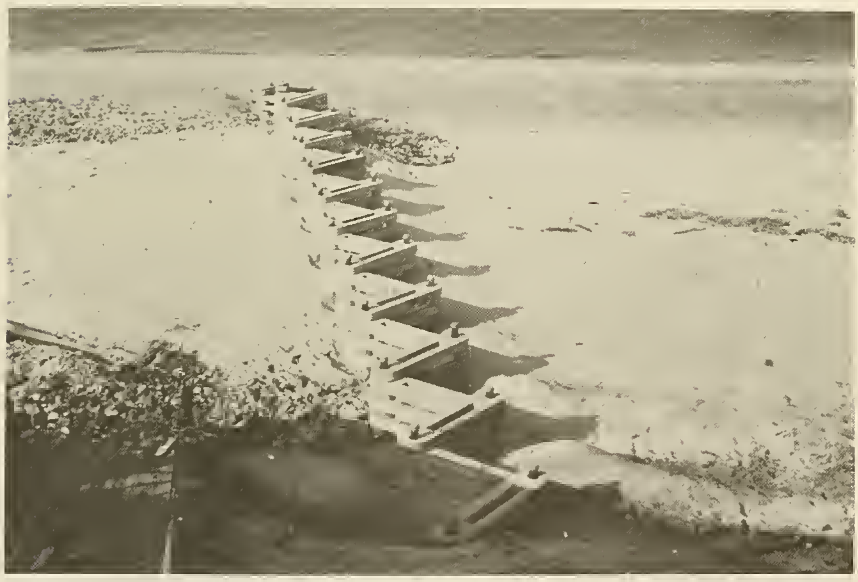
NY-32

NY-33

NY-34

NY-35



NY-36

NY-37

NY-38

NY-39

NY-40

NY-41

NY-42

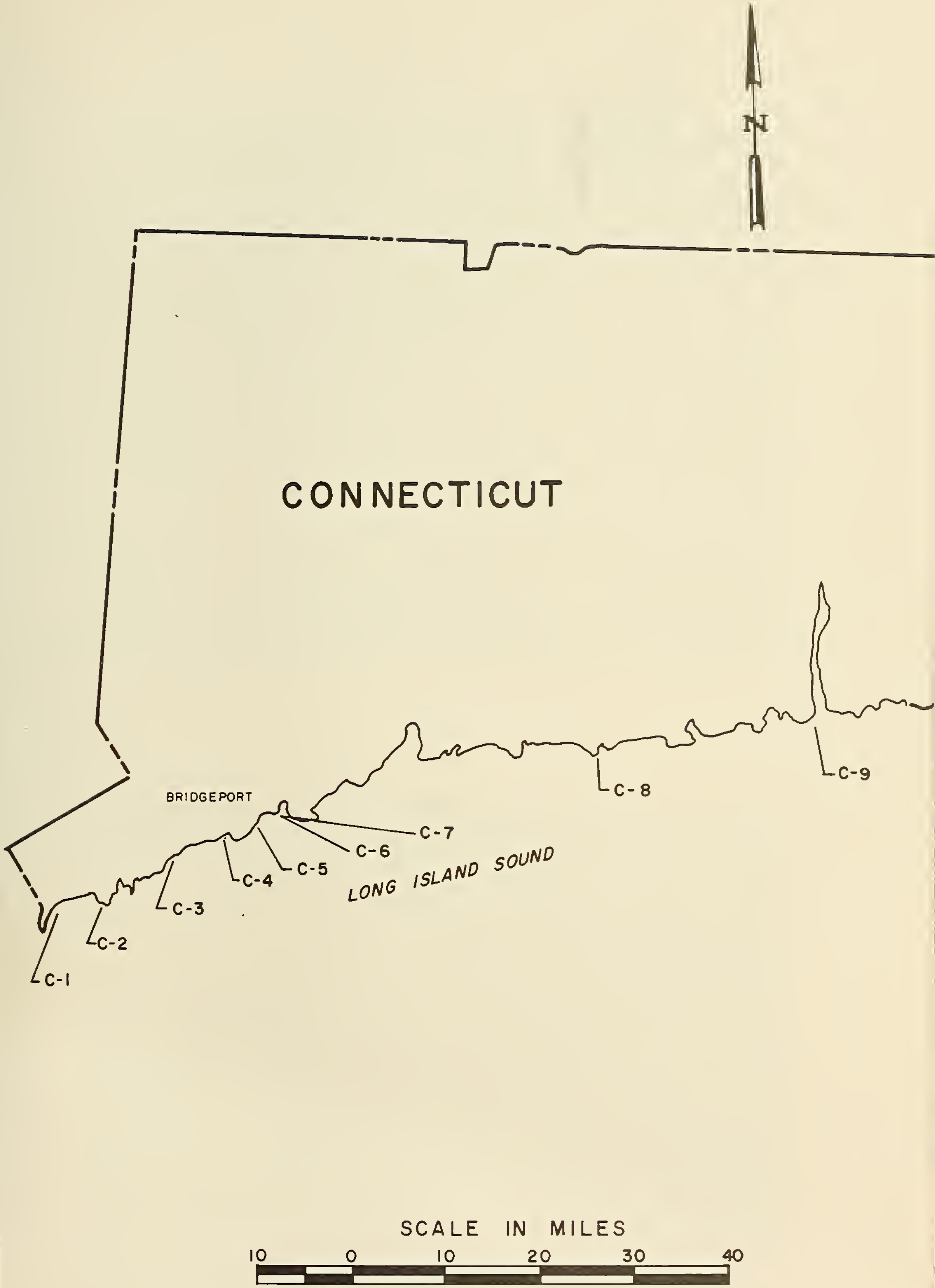
NY-43

NY-44

NY-45

NY-46

NY-47


N
CONNECTICUT
BRIDGEPORT
C-1
C-2
C-3
C-4
C-5
C-6
C-7
C-8
C-9
LONG ISLAND SOUND
SCALE IN MILES
10
0
10
20
30
40

LIST OF CAPTIONS—CONNECTICUT

C-1 Ledge outcrops and pocket beaches characterize the western Connecticut shoreline.

C-2 Cummings Park Beach, Stamford, Connecticut.

C-3 Compo Beach, Westport, Connecticut.

C-4 Sherwood Island State Park.

C-5 Jennings Beach, Fairfield, Connecticut.

C-6 Seaside Park, Bridgeport, Connecticut, west end before improvement.

C-7 Seaside Park, Bridgeport, Connecticut, west end, after improvement.

C-8 Hammonasset State Park Beach, Madison, Connecticut

C-9 Ocean Beach, New London , Connecticut.

C-1

C-2

C-3

C-4

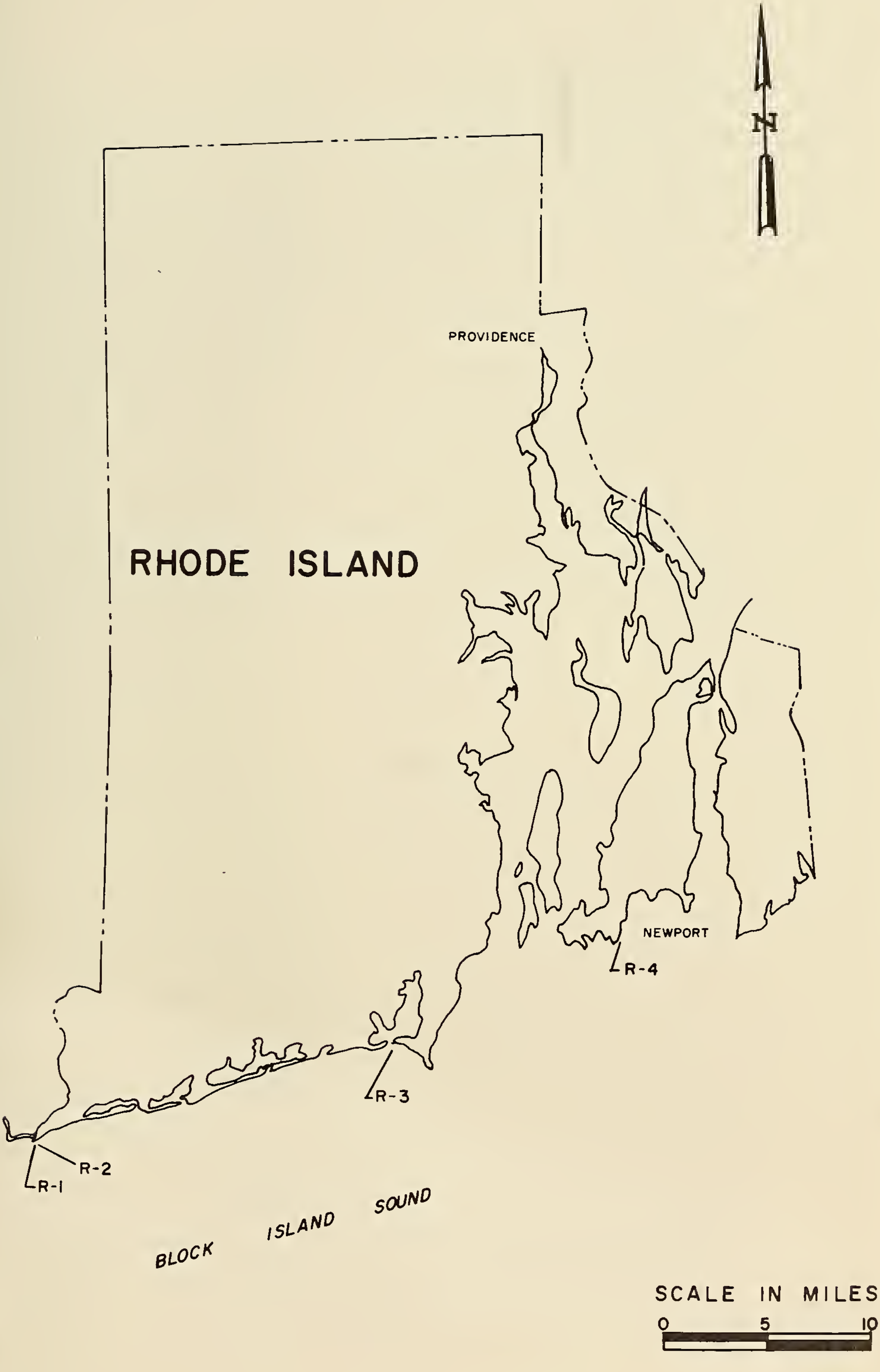
C-5

C-6

C-7

C-8

C-9



N
PROVIDENCE
RHODE ISLAND
NEWPORT
R-4
R-3
R-2
R-1
BLOCK ISLAND SOUND
SCALE IN MILES
0
5
10

LIST OF CAPTIONS—RHODE ISLAND

R-1 Napatree Beach, Westerly Rhode Island.

R-2 Misquamicut Beach, Westerly, Rhode Island—1964.

R-3 Sand Hill Cove Beach, Narragansett, Rhode Island.

R-4 Cliff Walk, Newport, Rhode Island, eroding embankment—1961.

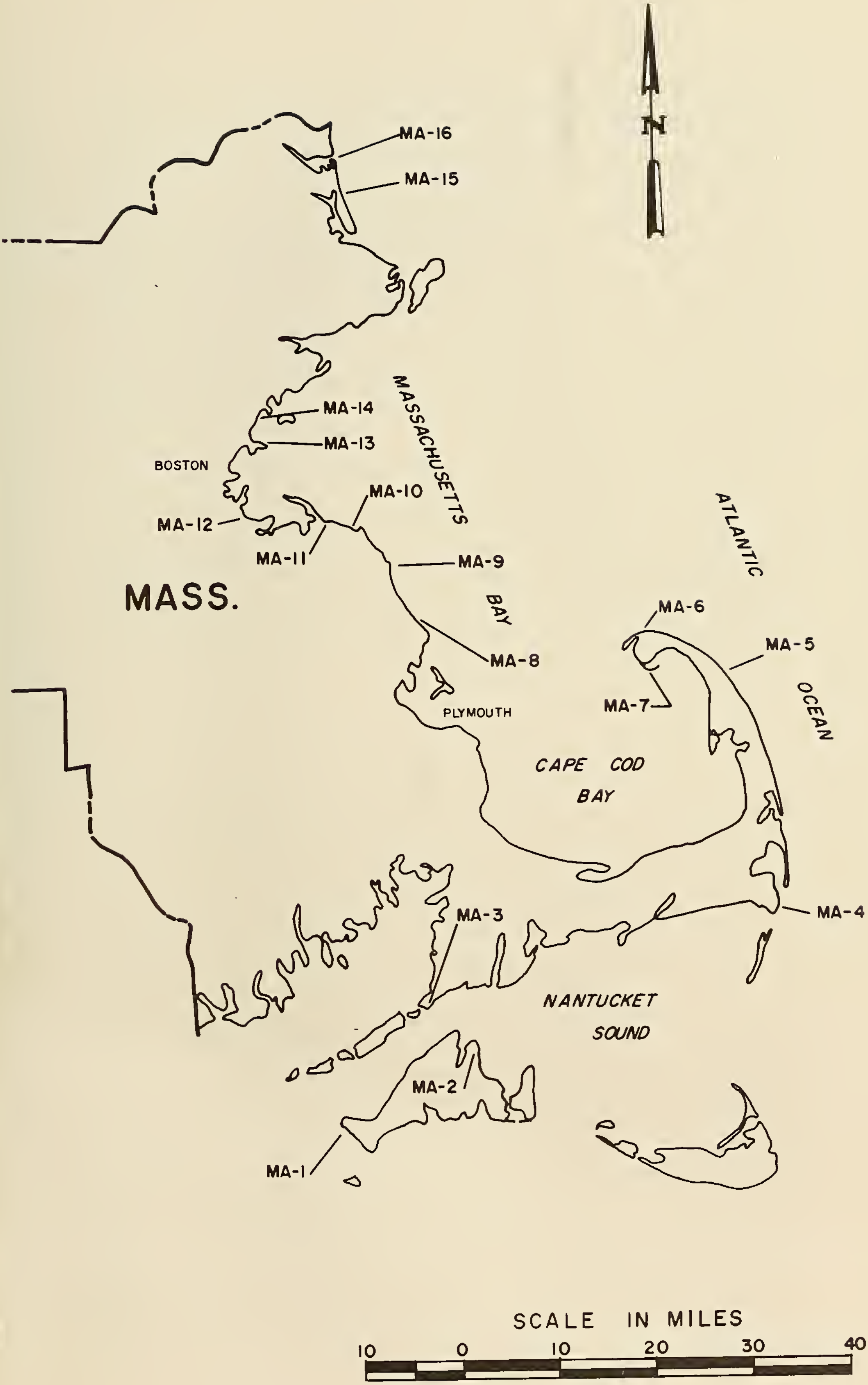

N
MISQUAMICUT
WATCH HILL
WATCH HILL
COVE
NAPATREE BEACH
Block Island Sound

R-1

R-2

R-3

R-4


N
MA-16
MA-15
MASSACHUSETTS
MA-14
MA-13
BOSTON
MA-10
MA-12
MA-11
MA-9
MASS.
BAY
ATLANTIC
MA-6
MA-5
MA-8
OCEAN
MA-7
PLYMOUTH
CAPE COD
BAY
MA-3
MA-4
NANTUCKET
SOUND
MA-2
MA-1
SCALE IN MILES
10
0
10
20
30
40

LIST OF CAPTIONS—MASSACHUSETTS

Ma- 1 Gay Head Cliffs, Martha's Vineyard, Massachusetts.

Ma- 2 Massive Stone Mound Protection Fronts Bluffs at East Chop, Massachusetts—1963.

Ma- 3 Private cottage development and fronting beach erosing control improvements—typical along the Cape Cod South Shore—1961.

Ma- 4 Looking southwest along Nauset Beach, Cape Cod, Mass.—1964.

Ma- 5 Looking southwest along eroding bluffs—North Truro Beach, Cape Cod, Massachusetts—1964.

Ma- 6 Provincetown, looking east along northerly exposure of Race Point, Cape Code, Massachusetts—1964.

Ma- 7 Bluffs or dunes form much of backshore fronting Cape Cod Bay, Massachusetts.

Ma- 8 Green Harbor—Brant Rock Beach, Marshfield, Massachusetts—1964.

Ma- 9 North Scituate Beach Erosion Control Improvement, North Scituate, Massachusetts.

Ma-10 Nantasket Beach, showing need for beach erosion control improvement, Hull, Massachusetts.

Ma-11 Wessagusset Beach Erosion Control Improvement, Weymouth, Massachusetts.

Ma-12 Quincy Shore (Wollaston Beach) Beach Erosion Control Improvements, Quincy, Massachusetts—1969.

Ma-13 Winthrop Beach, Winthrop, Massachusetts—1969.

Ma-14 Revere Beach, Revere, Massachusetts

Ma-15 Erosion along Oceanfront Shore, Plum Island, Massachusetts.

Ma-16 Erosion along South Shore—Merrimack River Entrance at Coast Guard Station—1970.

MA-1

MA-2

MA-3

MA-4

MA-5

MA-6

MA-7

MA-8

MA-9

MA-10

MA-11

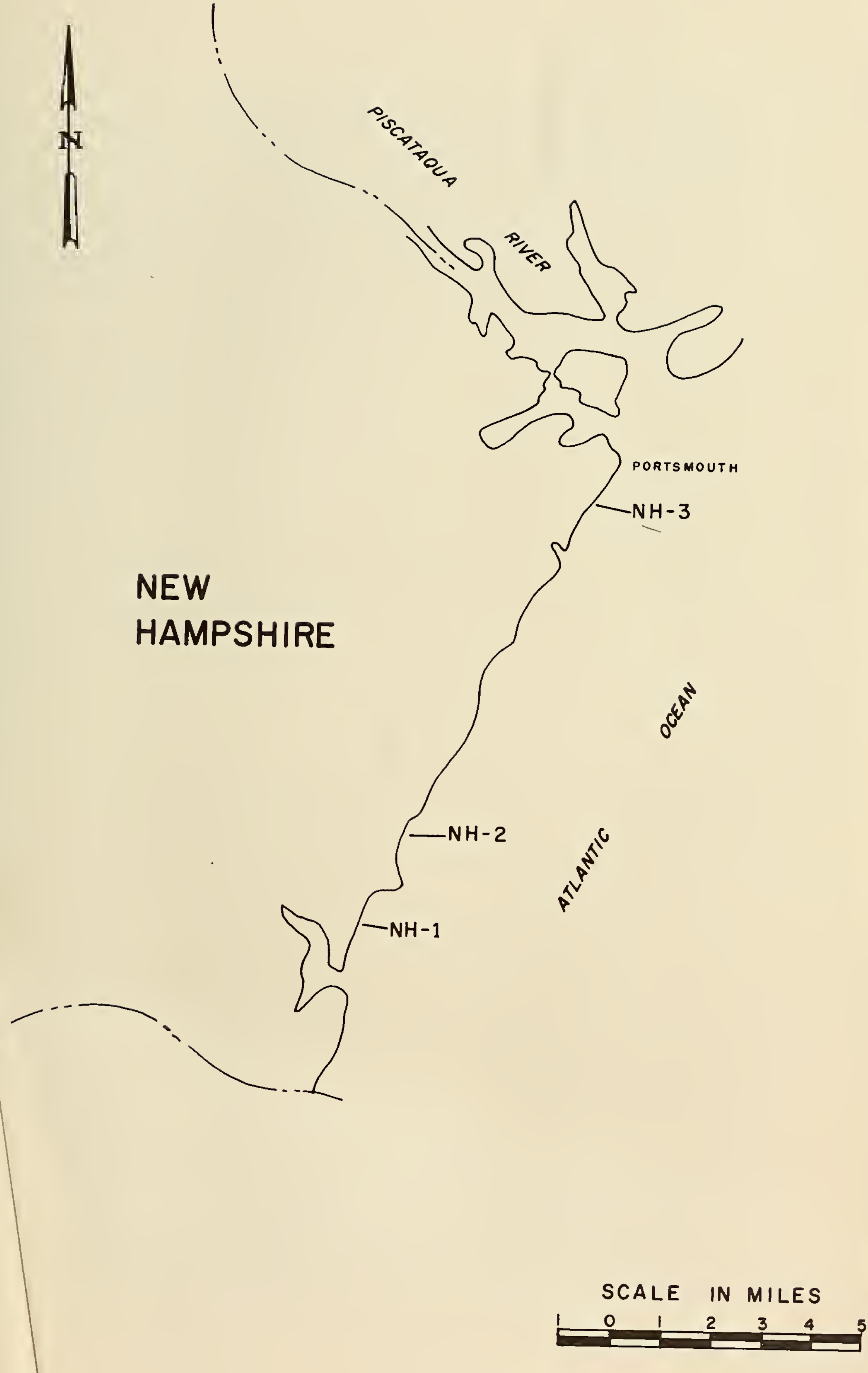
MA-12

MA-13

MA-14

MA-15

MA-16


N
PISCATAQUA
RIVER
PORTSMOUTH
NH-3
NEW
HAMPSHIRE
OCEAN
NH-2
ATLANTIC
NH-1
SCALE IN MILES
1 0 1 2 3 4 5

LIST OF CAPTIONS—NEW HAMPSHIRE

NH-1 Hampton Beach—New Hampshire's larger recreational beach, Hampton, New Hampshire.

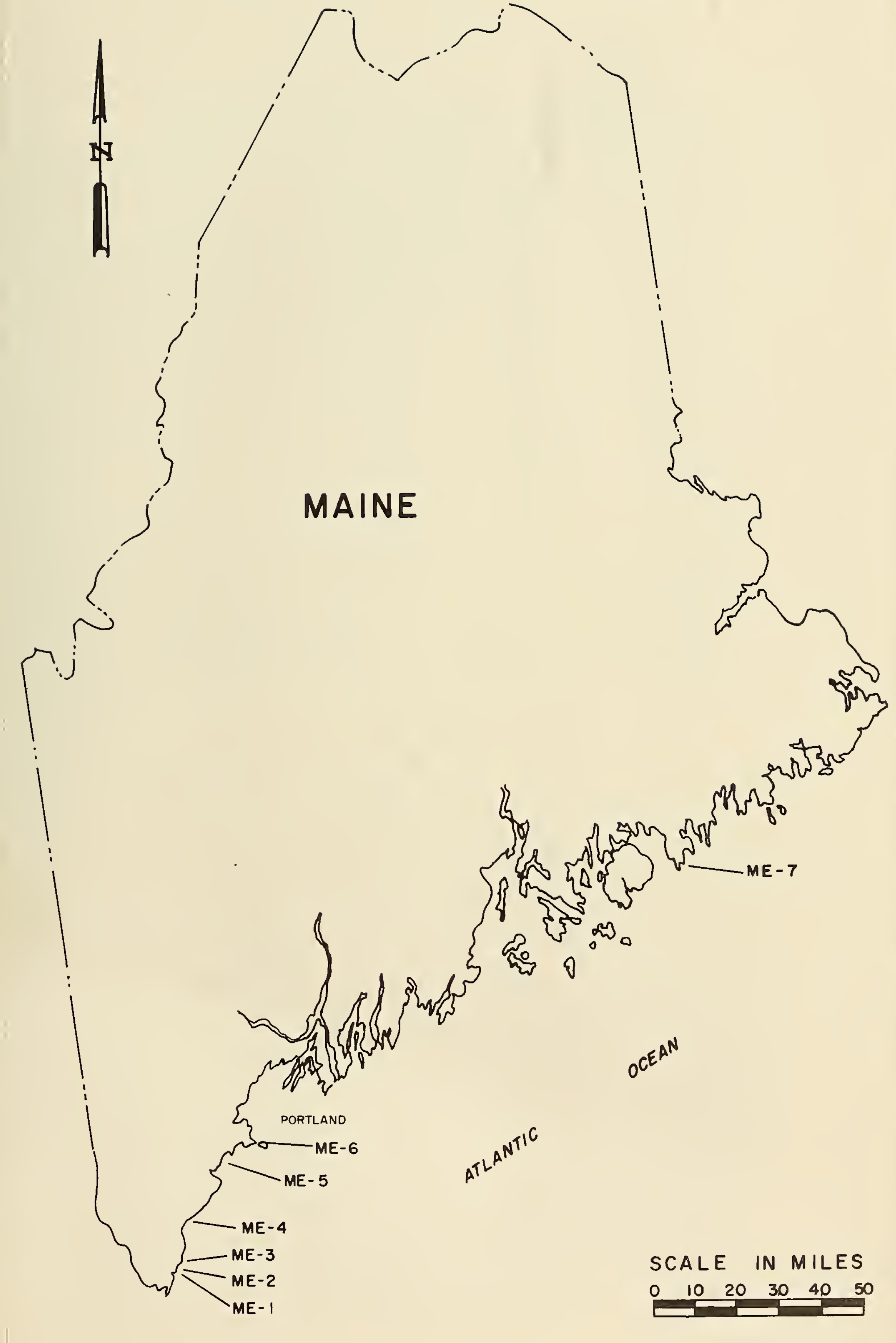
NH-2 Hampton—North Beach, frequent serious storms have eroded this beach sometimes with wave overtopping of highway.

NH-3 Wallis Sands State Beach, Rye, New Hampshire.

NH-1

NH-2

NH-3


N
MAINE
PORTLAND
ME-7
ME-6
ME-5
ME-4
ME-3
ME-2
ME-1
ATLANTIC
OCEAN
SCALE IN MILES
0 10 20 30 40 50

LIST OF CAPTIONS—MAINE

Me-1 Long Sands Beach, York, Maine—little dry beach available during normal high tide periods.

Me-2 Massive Rock Revetment—A commom type of erosion control along seaward face of Maine's coastal highways—1969.

Me-3 Short Sands Beach, York, Maine—seriously eroded surf zone—1969.

Me-4 Massive Seawall construction fronting private property—Drake's Island, Maine—1969.

Me-5 Old Orchard Beach, Maine's largest recreational beach—1969.

Me-6 Crescent Beach State Park, South Portland, Maine.

Me-7 Rocky shore and ledge outcrops characterizes the "down east" coast of Maine.

ME-1

ME-2

ME-3

ME-4

ME-5

ME-6

ME-7

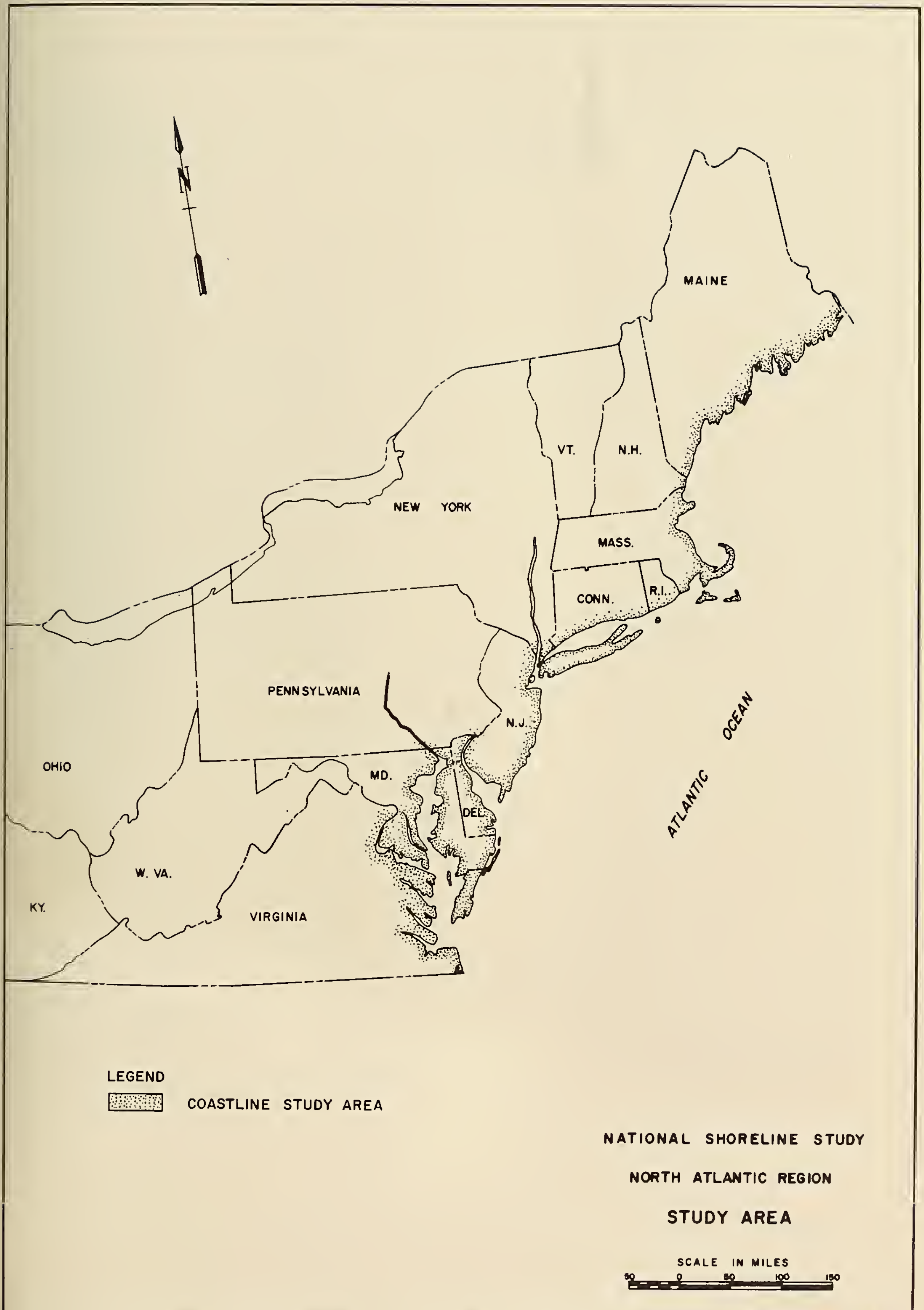
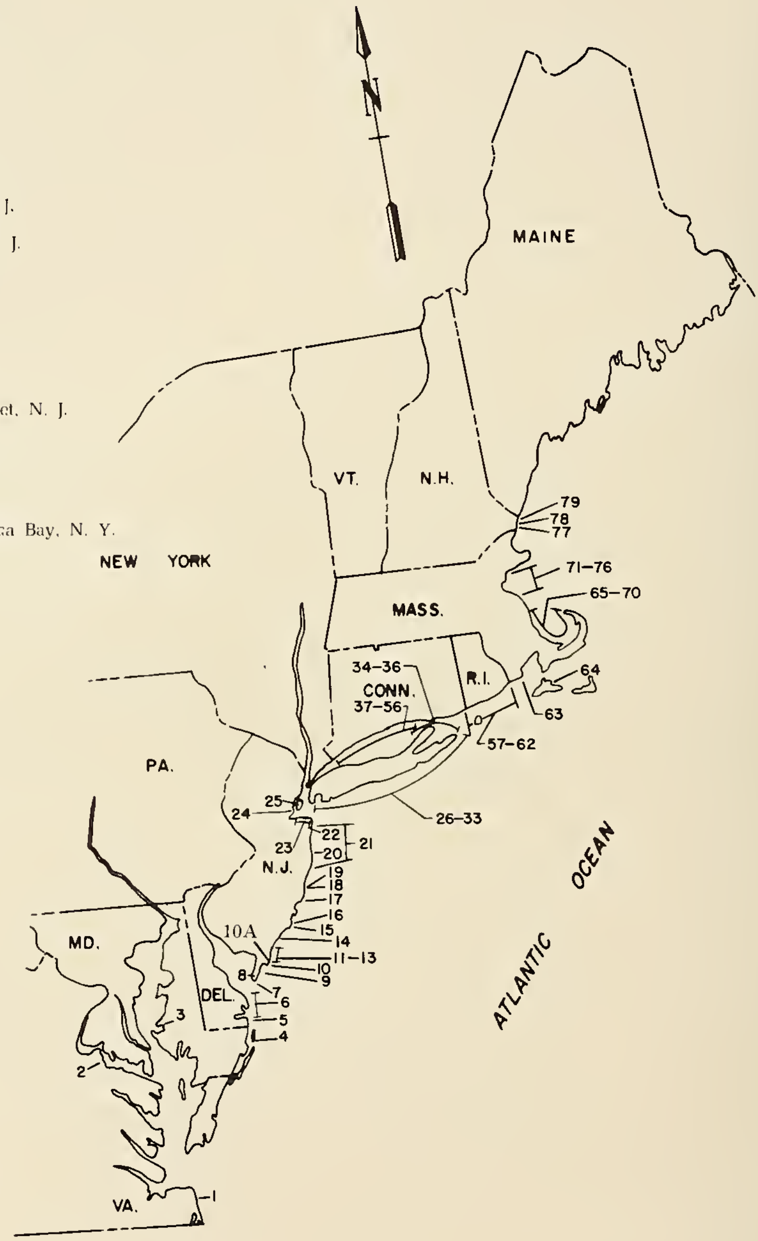

N
MAINE
VT.
N.H.
NEW YORK
MASS.
CONN.
R.I.
PENNSYLVANIA
N.J.
OHIO
MD.
DEL.
W. VA.
KY.
VIRGINIA
ATLANTIC OCEAN
LEGEND
COASTLINE STUDY AREA
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
STUDY AREA
SCALE IN MILES
50 0 50 100 150

PLATE 1

KEY

No.	Project
1	Virginia Beach, Va.
2	Colonial Beach, Va.
3	Oxford, Md.
4	Ocean City Harbor, Md.
5	Indian River Inlet and Bay, Del.
6	Coast of Deleware
7	Cape May City, N. J.
8	Cold Spring Inlet, N. J.
9	Five Mile Beach (North Wildwood), N. J.
10	Hereford Inlet, N. J.
11	Townsend Inlet and Seven Mile Beach, N. J.
12	Corson Inlet and Ludlam Beach, N. J.
13	Great Egg Harbor Inlet and Peck Beach, N. J.
14	Ventnor, Margate, Longport, N. J.
15	Atlantic City, N. J.
16	Absecon Inlet, N. J.
17	Long Beach Island, N. J.
18	Barnegat Light, N. J.
19	Barnegat Inlet, N. J.
20	Manasquan River and Inlet, N. J.
21	Atlantic Coast, Sandy Hook to Barnegat Inlet, N. J.
22	Shrewsbury River Inlet, N. J.
23	Sandy Hook Bay and Raritan Bay, N. J.
24	Perth Amboy, N. J.
25	Fort Wadsworth to Arthur Kill, N. Y.
26	East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, N. Y.
27	East Rockaway Inlet, N. Y.
28	Jones Inlet, N. Y.
29	Fire Island Inlet to Jones Inlet, N. Y.
30	Fire Island Inlet, N. Y.
31	Monriches Inlet, N. Y.
32	Shinnecock Inlet, N. Y.
33	Fire Island Inlet to Montauk Point, N. Y.
34	Lake Montauk Harbor, N. Y.
35	Sag Harbor, N. Y.
36	Mattituck Harbor, N. Y.
37	Greenwich Point Park, Conn.
38	Cummings Park Beach, Conn.
39	Cove Island Beach, Conn.
40	Calf Pasture Beach, Conn.
41	Compo Beach, Conn.
42	Sherwood Island State Park, Conn.
43	Burial Hill Beach, Conn.
44	Southport Beach, Conn.
45	Sasco Hill Beach, Conn.
46	Jennings Beach and Ash Creek, Conn.
47	Seaside Park, Conn.
48	Short Beach, Conn.
49	Silver Beach to Cedar Beach, Conn.
50	Gulf Beach, Conn.
51	Woodmont Shore, Conn.
52	Prospect Beach, Conn.
53	Lighthouse Point Park, Conn.
54	Guilford Point Beach, Conn.
55	Middle Beach, Conn.
56	Hammonasset Beach State Park, Conn.
57	Napatree Beach, R. I.
58	Misquamicut Beach, R. I.
59	Matunuck Beach, R. I.
60	Sand Hill Cove Beach, R. I.
61	Narragansett Pier, R. I.
62	Cliff Walk, R. I.
63	Clark Point, Mass.
64	Oak Bluffs Town Beach, Mass.
65	Provincetown Beach, Mass.
66	Thumpertown Beach, Mass.
67	Town Neck Beach, Mass.
68	Plymouth Town Beach, Mass.
69	Brant Rock, Mass.
70	North Scituate Beach, Mass.
71	Nantasket Beach, Mass.
72	Wessagussett Beach, Mass.
73	Quincy Shore Beach, Mass.
74	Winthrop Beach, Mass.
75	Revere Beach, Mass.
76	Lynn-Nahant, Mass.
77	Hampton Beach, N. H.
78	North Hampton Beach, N. H.
79	Wallis Sands State Beach, N. H.



REVISED

NATIONAL SHORELINE STUDY

NORTH ATLANTIC REGION

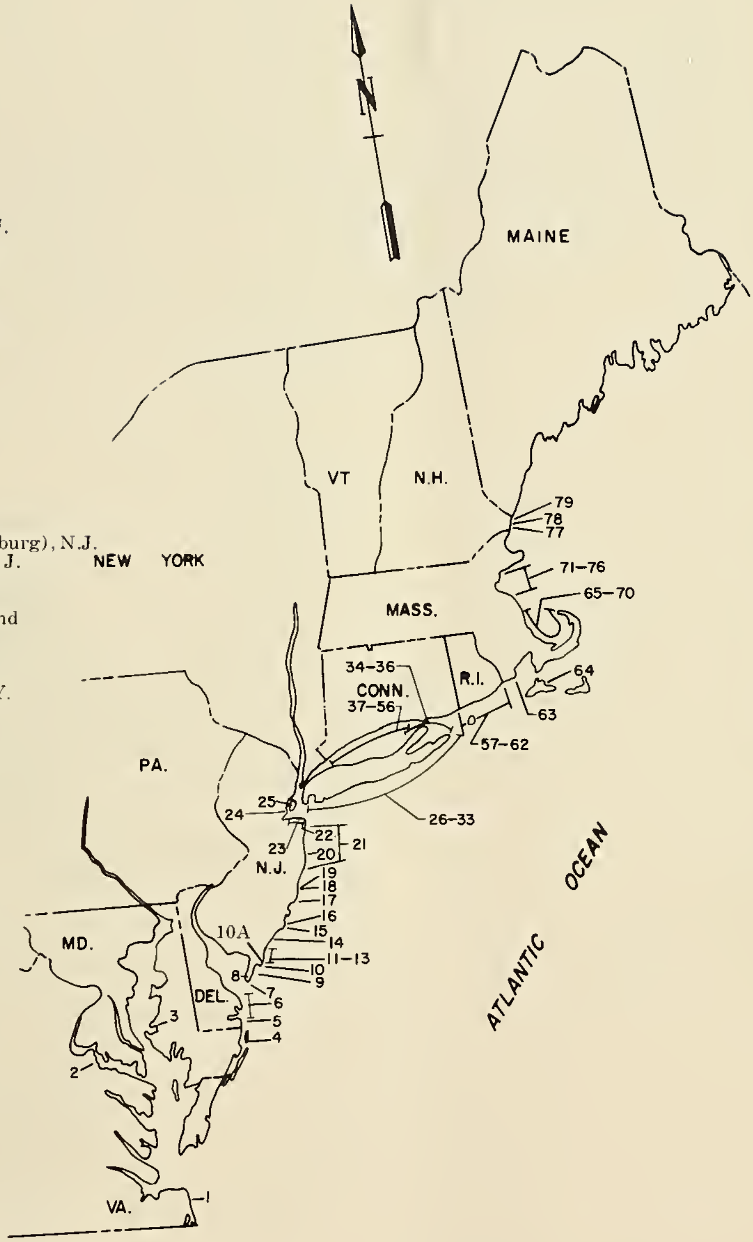
FEDERAL PROJECTS

SCALE IN MILES

50 0 50 100 150

KEY

No.	Project
1	Virginia Beach, Va.
2	Colonial Beach, Va.
3	Oxford, Md.
4	Ocean City Harbor, Md.
5	Indian River Inlet and Bay, Del.
6	Coast of Delaware
7	Cape May City, N. J.
8	Cold Spring Inlet, N. J.
9	Five Mile Beach (North Wildwood), N. J.
10	Hereford Inlet, N. J.
10A	Townsend Inlet and Seven Mile Beach
11	Corson Inlet and Ludlam Beach
12	Great Egg Harbor Inlet and Peck Beach
13	Ventnor, Margate, Longport, N. J.
14	Atlantic City, N. J.
15	Absecon Inlet, N. J.
16	Long Beach Island, N. J.
17	Barnegat Light, N. J.
18	Barnegat Inlet, N. J.
19	Manasquan Inlet, N. J.
20	Sea Bright to Seaside Pk., N. J.
21	Shrewsbury River Inlet, N. J.
22	Sandy Hook Bay (Keansburg & E. Keansburg), N.J. and Raritan Bay (Madison Township), N. J.
23	Perth Amboy, N. J.
24	Fort Wadsworth to Arthur Kill, N. Y.
25	East Rockaway Inlet to Rockaway Inlet and Jamaica Bay, N. Y.
26	Fire Island Inlet to Jones Inlet, N. Y.
27	Fire Island Inlet to Montauk Point, N. Y.
28	Greenwich Point Park, Conn.
29	Cummings Park Beach, Conn.
30	Cove Island Beach, Conn.
31	Calf Pasture Beach, Conn.
32	Compo Beach, Conn.
33	Sherwood Island State Park, Conn.
34	Burial Hill Beach, Conn.
35	Southport Beach, Conn.
36	Sasco Hill Beach, Conn.
37	Jennings Beach and Ash Creek, Conn.
38	Seaside Park, Conn.
39	Short Beach, Conn.
40	Silver Beach to Cedar Beach, Conn.
41	Gulf Beach, Conn.
42	Woodmont Beach, Conn.
43	Prospect Beach, Conn.
44	Lighthouse Point Park Beach, Conn.
45	Guilford Point Beach, Conn.
46	Middle Beach, Conn.
47	Hammonasset Beach, Conn.
48	Napatree Beach, R. I.
49	Misquamicut Beach, R. I.
50	Matunuck Beach, R. I.
51	Point Judith, R. I.
52	Cliff Walk, R. I.
53	Clark Point Beach, Mass.
54	Oak Bluffs Town Beach, Mass.
55	Provincetown Beach, Mass.
56	Thumpertown Beach, Mass.
57	Town Neck Beach, Mass.
58	Plymouth Town Beach, Mass.
59	Brant Rock Beach, Mass.
60	North Scituate Beach, Mass.
61	Wessagusset Beach, Mass.
62	Quincy Shore Beach, Mass.
63	Winthrop Beach, Mass.
64	Revere Beach, Mass.
65	Lynn-Nahant Beach, Mass.
66	Hampton Beach, N. H.
67	North Hampton Beach, N. H.
68	Wallis Sands Beach, N. H.



SUPERSEDED

NATIONAL SHORELINE STUDY

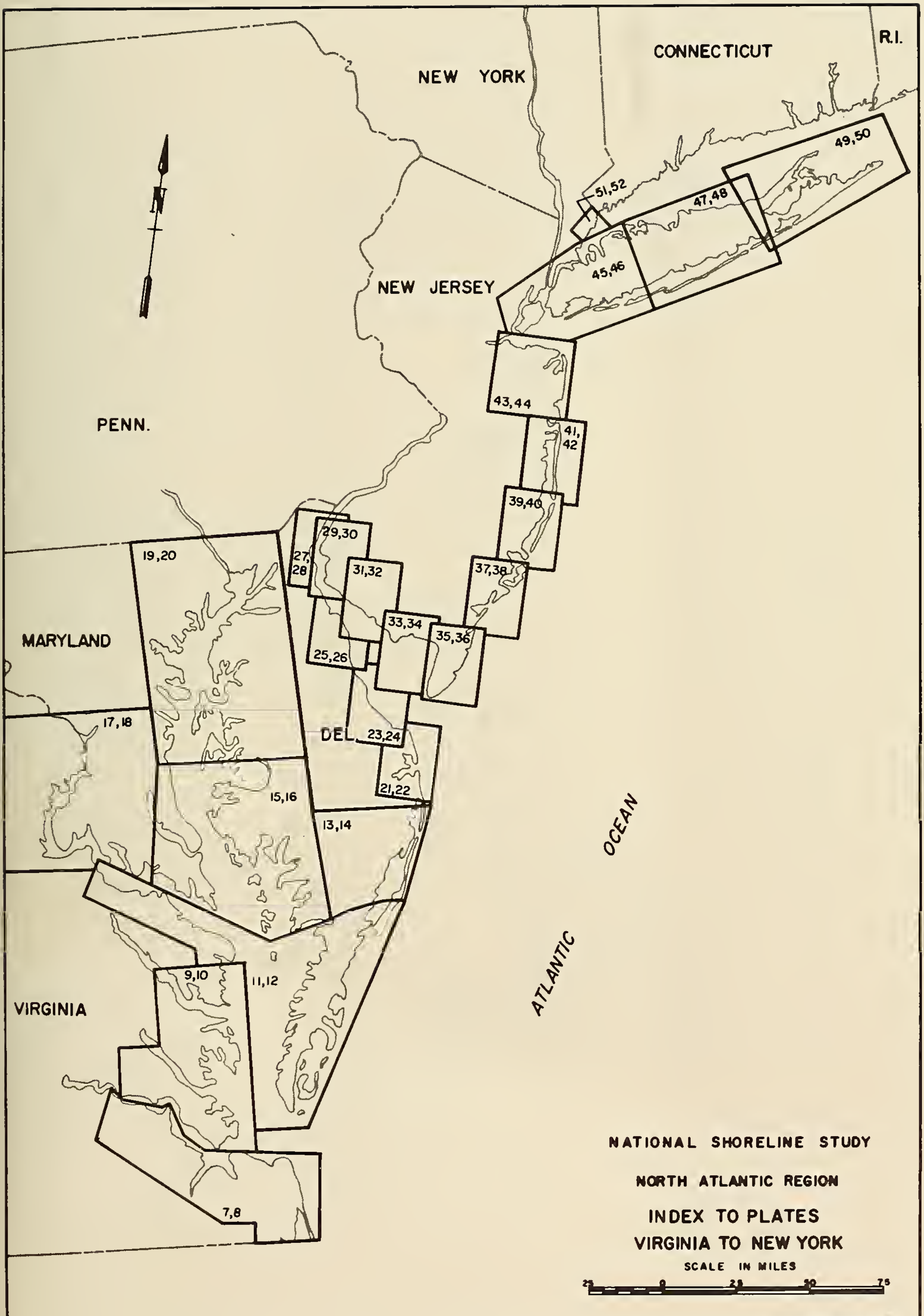
NORTH ATLANTIC REGION

FEDERAL PROJECTS

SCALE IN MILES

50 0 50 100 150

PLATE 2


NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
INDEX TO PLATES
VIRGINIA TO NEW YORK
SCALE IN MILES
NEW YORK
CONNECTICUT
R.I.
NEW JERSEY
PENN.
MARYLAND
DEL.
VIRGINIA
ATLANTIC OCEAN
N
49,50
51,52
47,48
45,46
43,44
41, 42
39,40
37,38
35,36
33,34
31,32
29,30
27, 28
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19,20
17,18
15,16
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11,12
9,10
7,8

PLATE 3

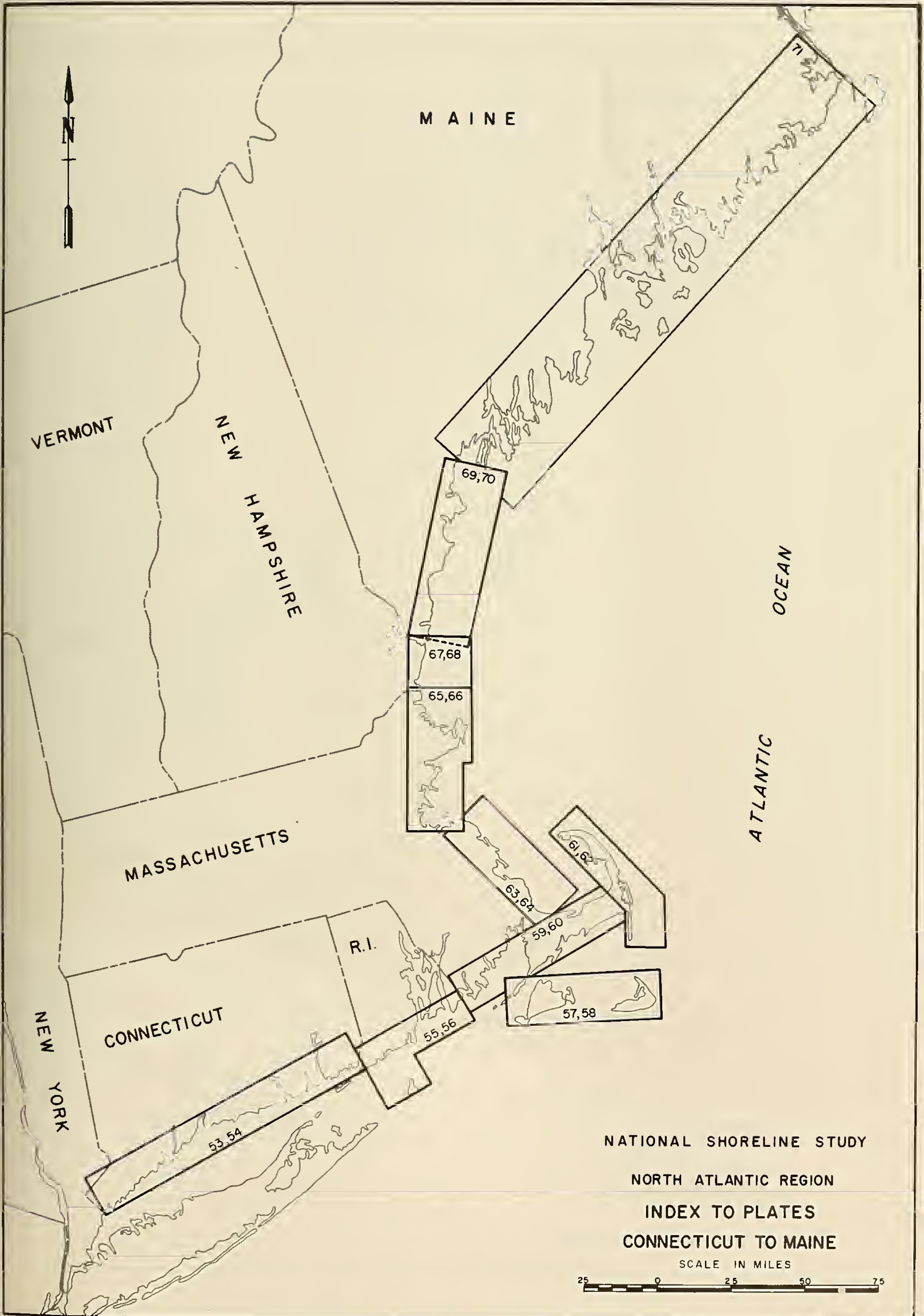
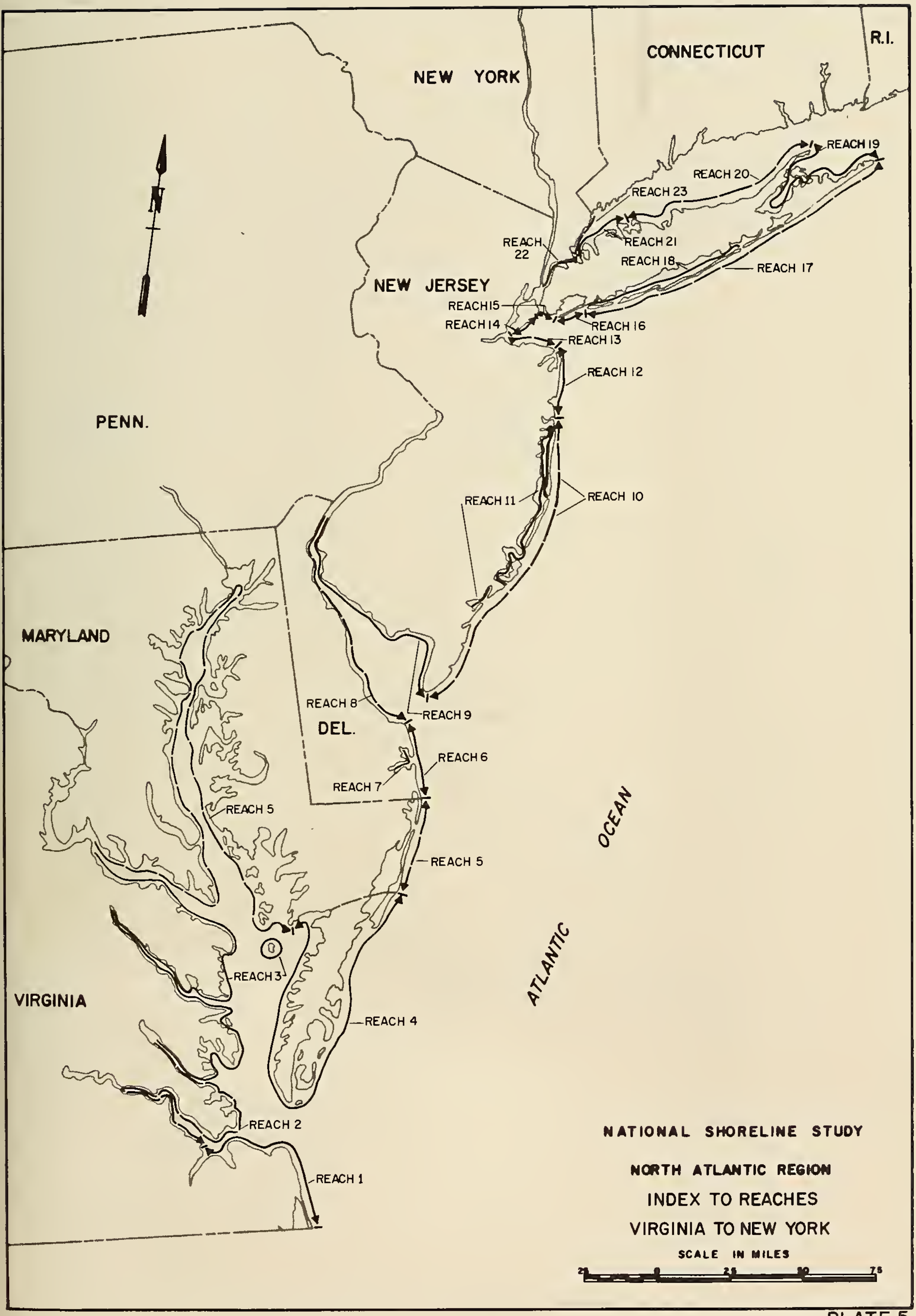

MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
R.I.
CONNECTICUT
NEW YORK
ATLANTIC OCEAN
71
69,70
67,68
65,66
63,64
61,62
59,60
57,58
55,56
53,54
N
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
INDEX TO PLATES
CONNECTICUT TO MAINE
SCALE IN MILES
25 0 25 50 75

PLATE 4



CONNECTICUT
R.I.
NEW YORK
NEW JERSEY
PENN.
MARYLAND
DEL.
VIRGINIA
ATLANTIC
OCEAN
N
REACH 1
REACH 2
REACH 3
REACH 4
REACH 5
REACH 5
REACH 6
REACH 7
REACH 8
REACH 9
REACH 10
REACH 11
REACH 12
REACH 13
REACH 14
REACH 15
REACH 16
REACH 17
REACH 18
REACH 19
REACH 20
REACH 21
REACH 22
REACH 23
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
INDEX TO REACHES
VIRGINIA TO NEW YORK
SCALE IN MILES
25 0 25 50 75

PLATE 5

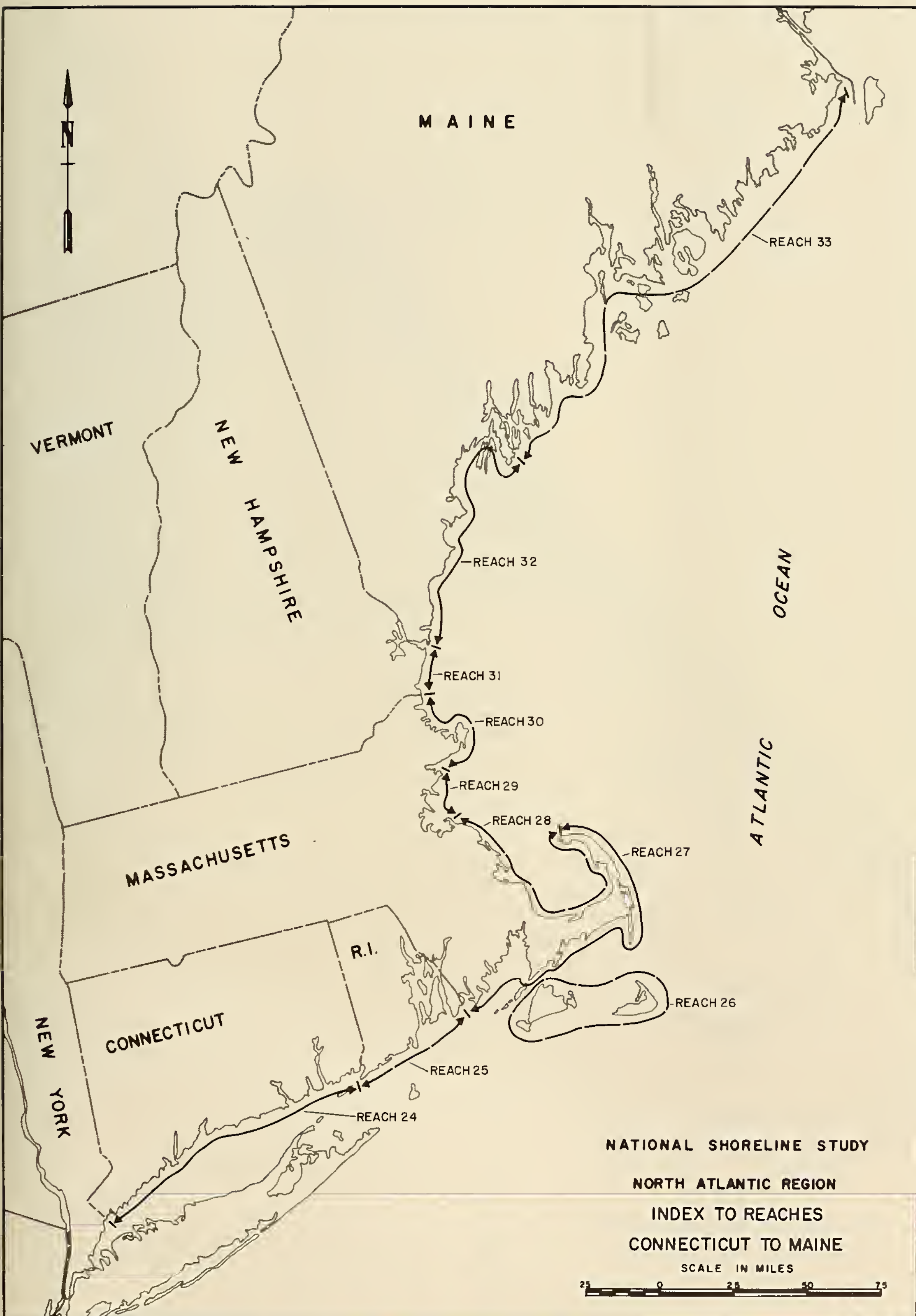
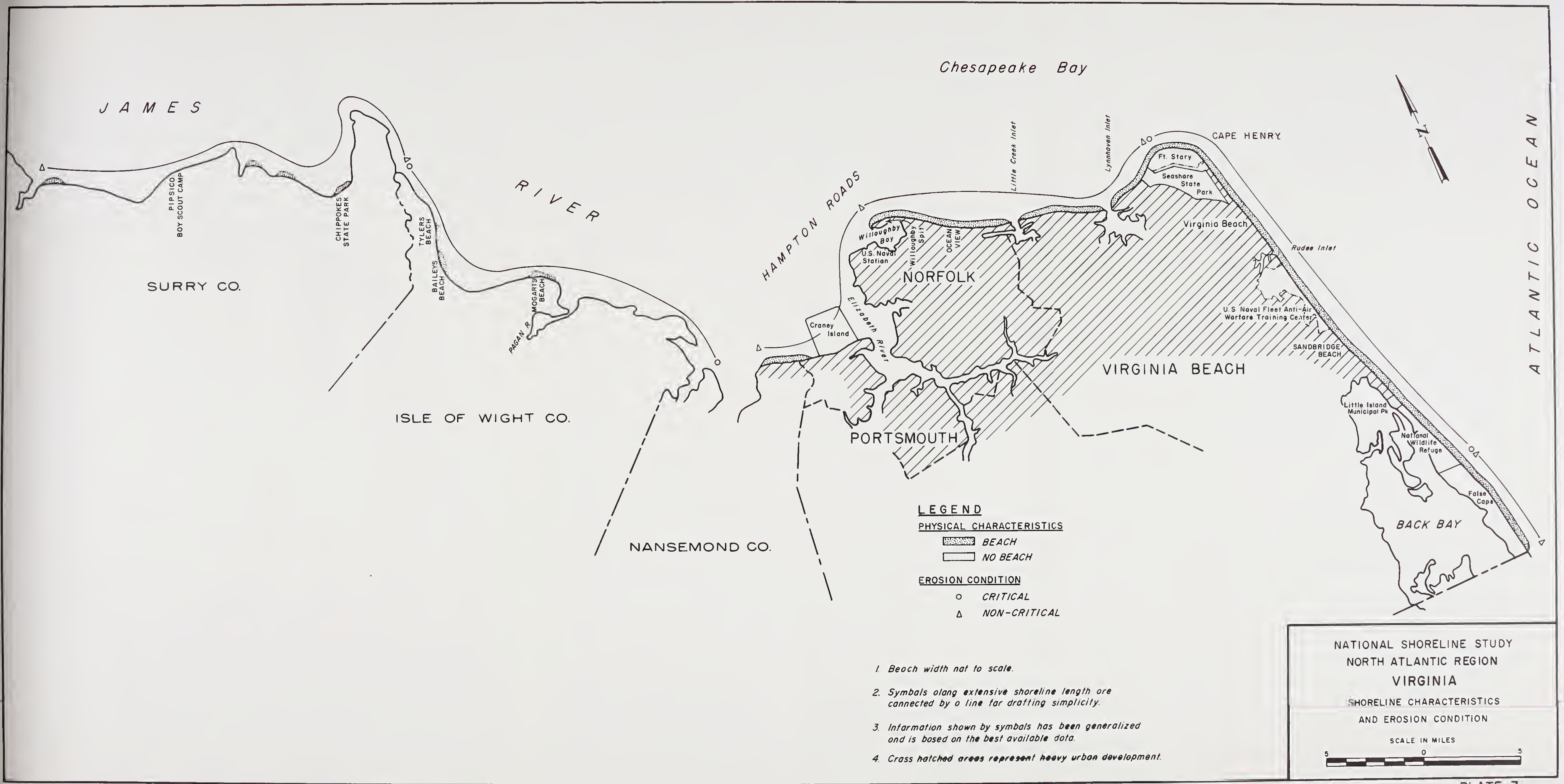
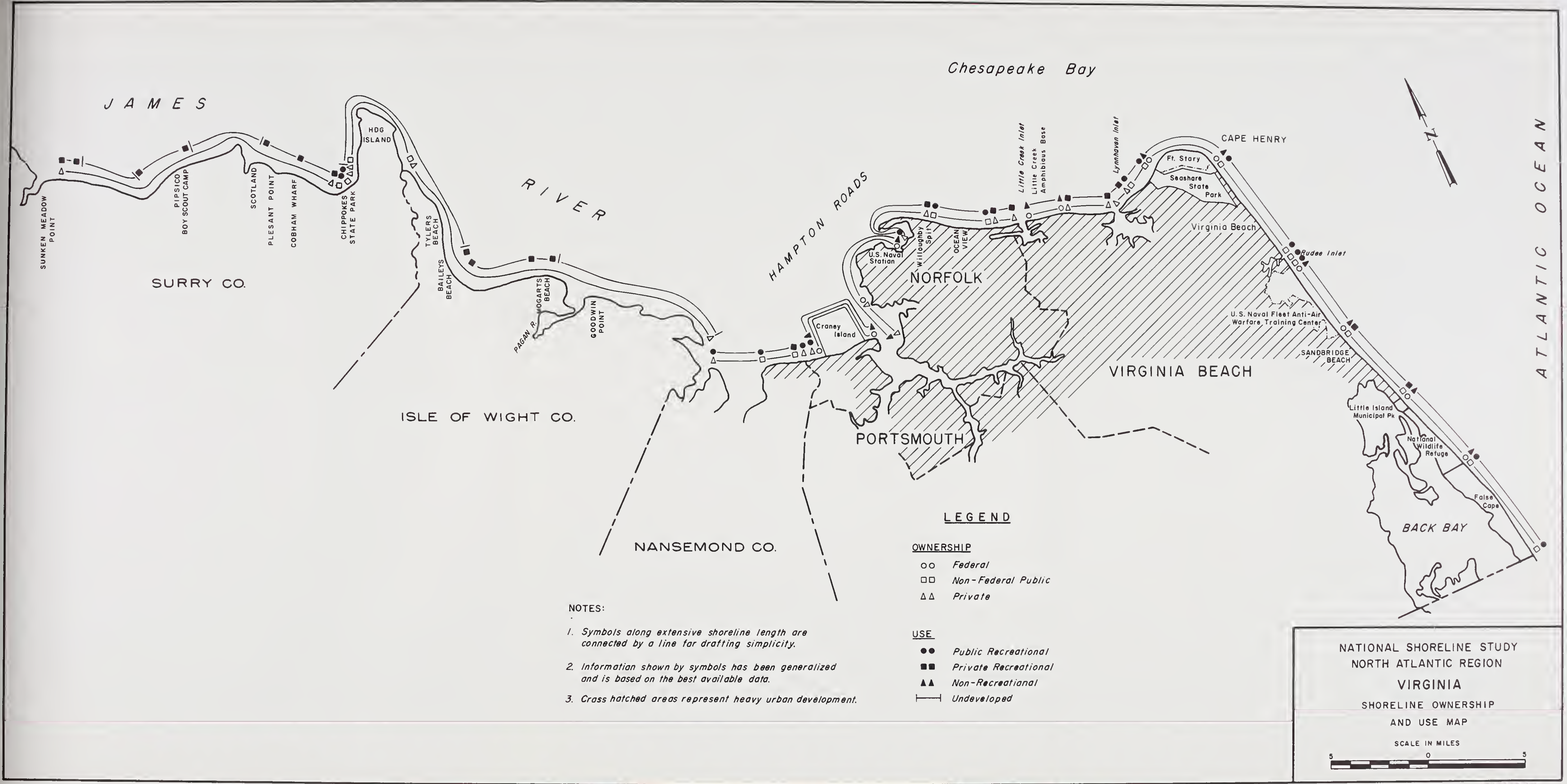

MAINE
VERMONT
NEW HAMPSHIRE
MASSACHUSETTS
R.I.
CONNECTICUT
NEW YORK
ATLANTIC
OCEAN
N
REACH 33
REACH 32
REACH 31
REACH 30
REACH 29
REACH 28
REACH 27
REACH 26
REACH 25
REACH 24
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
INDEX TO REACHES
CONNECTICUT TO MAINE
SCALE IN MILES
25 0 25 50 75

PLATE 6



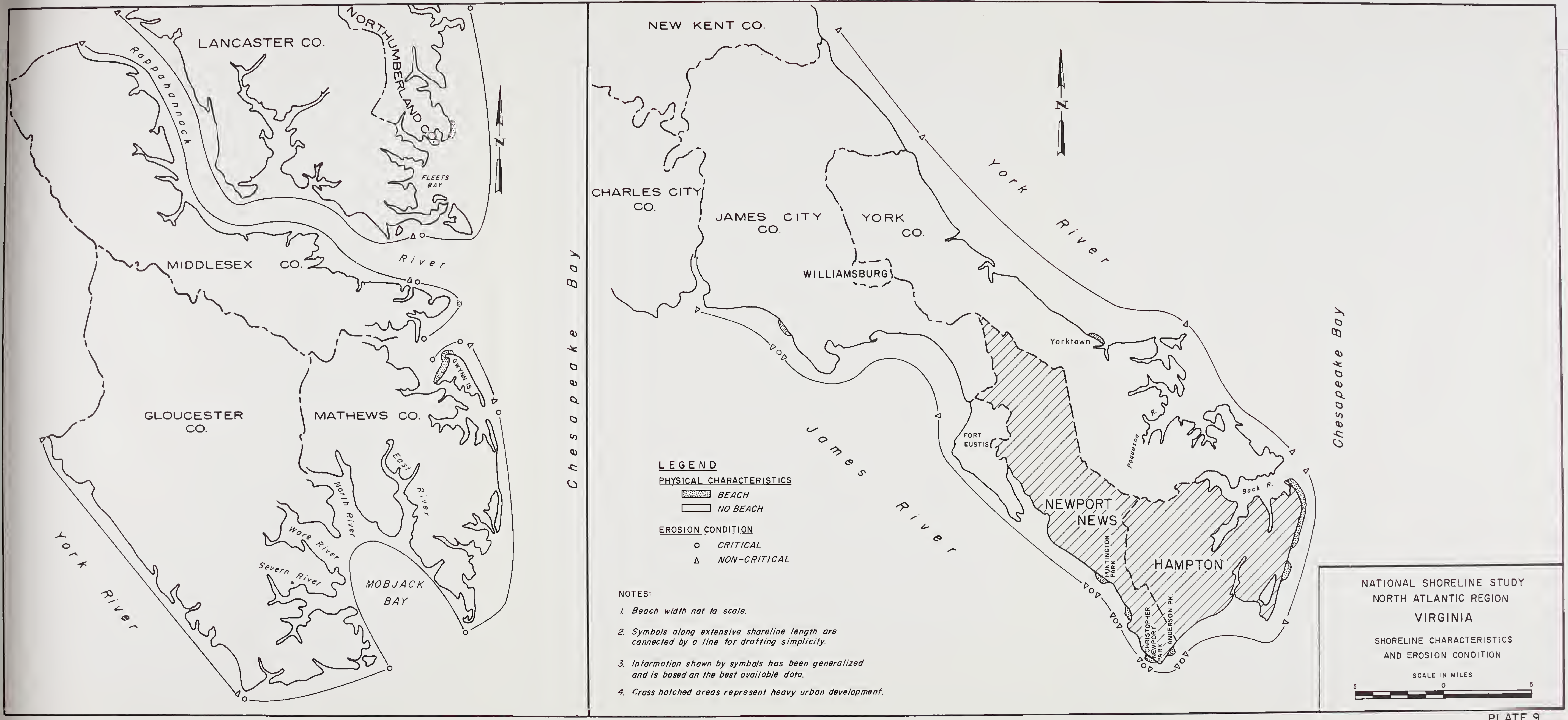
Chesapeake Bay
JAMES
RIVER
HAMPTON ROADS
ATLANTIC OCEAN
N
PIPSICO BOY SCOUT CAMP
CHIPPOKES STATE PARK
TYLERS BEACH
BAILEYS BEACH
MOGARTS BEACH
PAGAN R.
SURRY CO.
ISLE OF WIGHT CO.
NANSEMOND CO.
Craney Island
Elizabeth River
Willoughby Bay
U.S. Naval Station
Willoughby Spit
OCEAN VIEW
NORFOLK
PORTSMOUTH
Little Creek Inlet
Lynnhaven Inlet
CAPE HENRY
Ft. Story
Seashore State Park
Virginia Beach
Rudee Inlet
U.S. Naval Fleet Anti-Air Warfare Training Center
SANDBRIDGE BEACH
VIRGINIA BEACH
Little Island Municipal Pk
National Wildlife Refuge
False Cape
BACK BAY
LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
o CRITICAL
Δ NON-CRITICAL
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
4. Cross hatched areas represent heavy urban development.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
VIRGINIA
SHORELINE CHARACTERISTICS
AND EROSION CONDITION
SCALE IN MILES
5 0 5

PLATE 7



JAMES
RIVER
Chesapeake Bay
HAMPTON ROADS
ATLANTIC OCEAN
SUNKEN MEADOW POINT
PIPSICO BOY SCOUT CAMP
SCOTLAND
PLESANT POINT
COBHAM WHARF
CHIPPOKES STATE PARK
HOG ISLAND
TYLERS BEACH
BAILEYS BEACH
HOGARTS BEACH
PAGAN R.
GOODWIN POINT
SURRY CO.
ISLE OF WIGHT CO.
NANSEMOND CO.
Craney Island
U.S. Naval Station
Willoughby Spit
OCEAN VIEW
NORFOLK
PORTSMOUTH
Little Creek Inlet
Little Creek Amphibious Base
Lynnhaven Inlet
CAPE HENRY
Ft. Story
Seashore State Park
Virginia Beach
Rudee Inlet
U.S. Naval Fleet Anti-Air Warfare Training Center
SANDBRIDGE BEACH
VIRGINIA BEACH
Little Island Municipal Pk
National Wildlife Refuge
False Cape
BACK BAY
N
LEGEND
OWNERSHIP
Federal
Non-Federal Public
Private
USE
Public Recreational
Private Recreational
Non-Recreational
Undeveloped
NOTES:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
2. Information shown by symbols has been generalized and is based on the best available data.
3. Cross hatched areas represent heavy urban development.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
VIRGINIA
SHORELINE OWNERSHIP
AND USE MAP
SCALE IN MILES
5 0 5

PLATE 8



LANCASTER CO.
NORTHUMBERLAND CO.
Rappahannock
River
FLEETS BAY
N
MIDDLESEX CO.
GWYNN IS.
GLOUCESTER CO.
MATHEWS CO.
East River
North River
Ware River
Severn River
MOBJACK BAY
York River
Chesapeake Bay
NEW KENT CO.
CHARLES CITY CO.
JAMES CITY CO.
YORK CO.
WILLIAMSBURG
York River
Yorktown
Poquoson R.
FORT EUSTIS
James River
NEWPORT NEWS
HAMPTON
HUNTINGTON PARK
CHRISTOPHER NEWPORT PARK
ANDERSON PK.
Back R.
LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
NOTES:
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
4. Cross hatched areas represent heavy urban development.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
VIRGINIA
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
5 0 5

PLATE 9

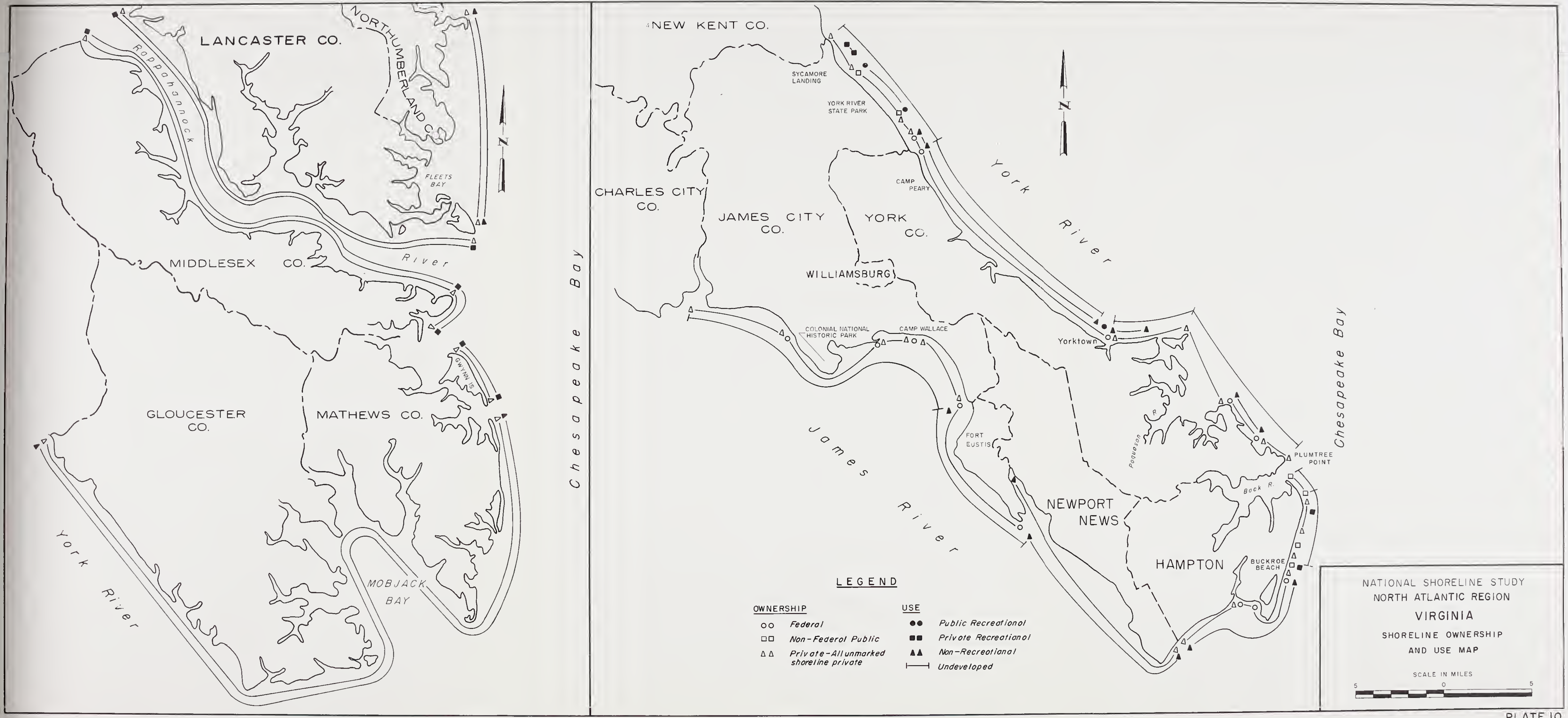
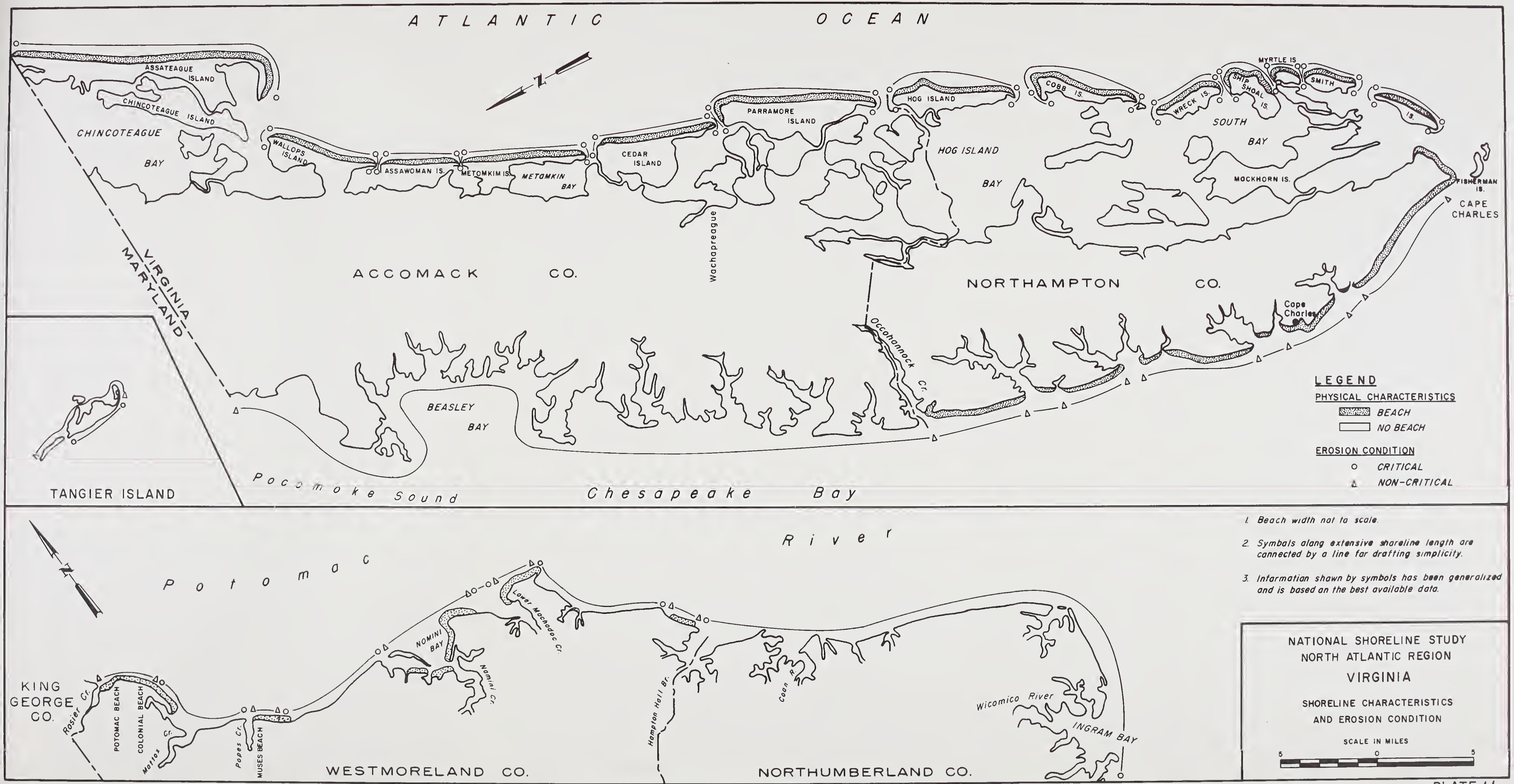

LANCASTER CO.
NORTHUMBERLAND CO.
Rappahannock
River
FLEETS BAY
MIDDLESEX CO.
GLOUCESTER CO.
MATHEWS CO.
GWYNN IS.
MOBJACK BAY
York River
Chesapeake Bay
N
NEW KENT CO.
CHARLES CITY CO.
JAMES CITY CO.
YORK CO.
WILLIAMSBURG
SYCAMORE LANDING
YORK RIVER STATE PARK
CAMP PEARY
COLONIAL NATIONAL HISTORIC PARK
CAMP WALLACE
Yorktown
FORT EUSTIS
James River
York River
Poquoson R.
PLUMTREE POINT
Back R.
NEWPORT NEWS
HAMPTON
BUCKROE BEACH
Chesapeake Bay
LEGEND
OWNERSHIP
Federal
Non-Federal Public
Private-All unmarked shoreline private
USE
Public Recreational
Private Recreational
Non-Recreational
Undeveloped
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
VIRGINIA
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
5
0
5

PLATE 10



ATLANTIC OCEAN
N
ASSATEAGUE ISLAND
CHINCOTEAGUE ISLAND
CHINCOTEAGUE BAY
WALLOPS ISLAND
ASSAWOMAN IS.
METOMKIM IS.
METOMKIN BAY
CEDAR ISLAND
PARRAMORE ISLAND
HOG ISLAND
HOG ISLAND BAY
COBB IS.
WRECK IS.
SHIP SHOAL IS.
MYRTLE IS
SMITH IS.
SOUTH BAY
MOCKHORN IS.
FISHERMAN IS.
CAPE CHARLES
Wachapreague
VIRGINIA
MARYLAND
ACCOMACK CO.
NORTHAMPTON CO.
Occohannock Cr.
Cape Charles
BEASLEY BAY
TANGIER ISLAND
Pocomoke Sound
Chesapeake Bay
LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
Potomac River
N
Lower Machodoc Cr.
NOMINI BAY
Nomini Cr.
KING GEORGE CO.
Rosier Cr.
POTOMAC BEACH
COLONIAL BEACH
Mattox Cr.
Popes Cr.
MUSES BEACH
Hampton Hall Br.
Coan R.
Wicomico River
INGRAM BAY
WESTMORELAND CO.
NORTHUMBERLAND CO.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
VIRGINIA
SHORELINE CHARACTERISTICS
AND EROSION CONDITION
SCALE IN MILES
5
0
5

PLATE 11

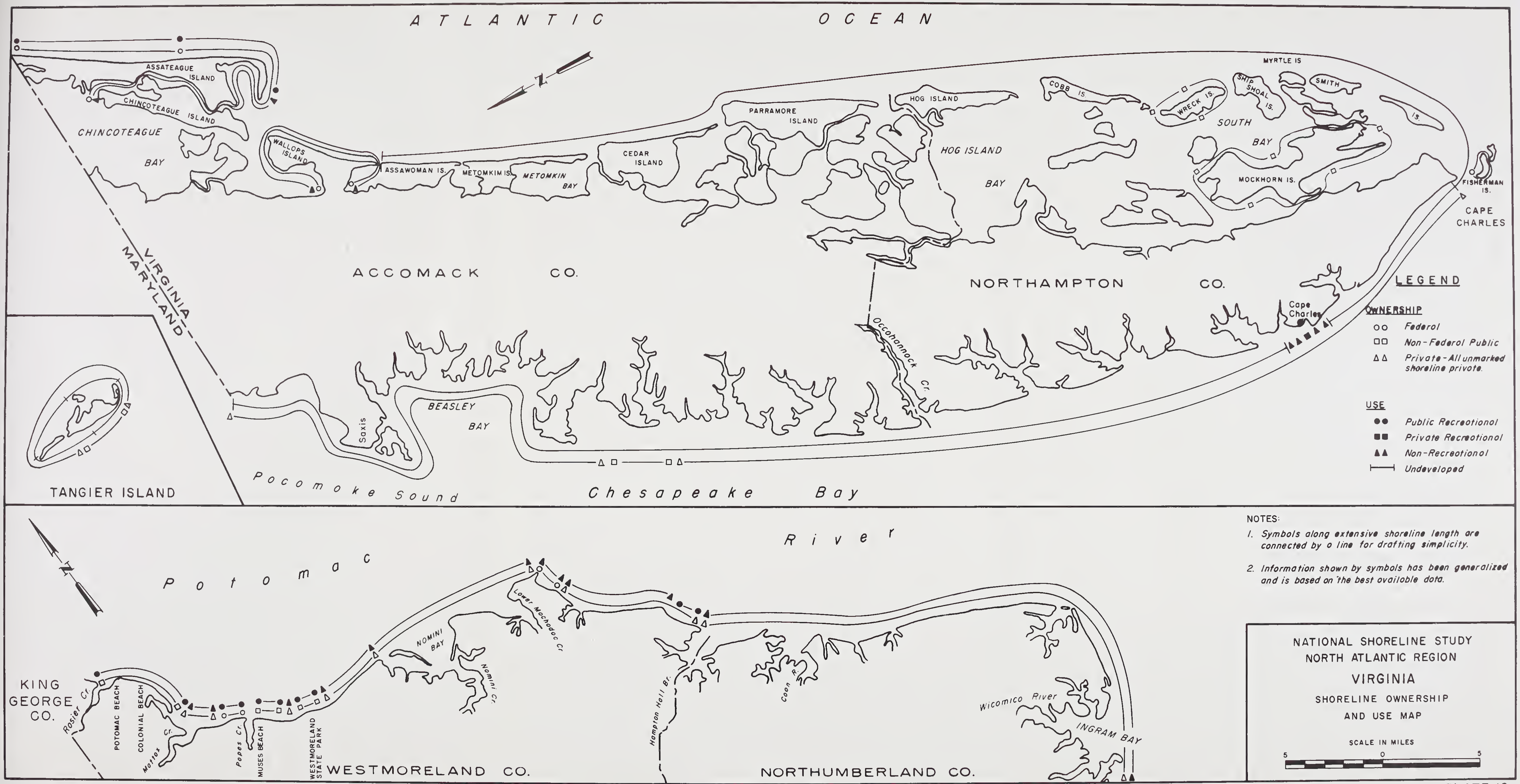

ATLANTIC OCEAN
ASSATEAGUE ISLAND
CHINCOTEAGUE ISLAND
CHINCOTEAGUE BAY
WALLOPS ISLAND
ASSAWOMAN IS.
METOMKIM IS.
METOMKIN BAY
CEDAR ISLAND
PARRAMORE ISLAND
HOG ISLAND
HOG ISLAND BAY
COBB IS.
WRECK IS.
SHIP SHOAL IS.
MYRTLE IS
SMITH IS.
SOUTH BAY
MOCKHORN IS.
FISHERMAN IS.
CAPE CHARLES
VIRGINIA
MARYLAND
ACCOMACK CO.
NORTHAMPTON CO.
Cape Charles
Occohannock Cr.
Saxis
BEASLEY BAY
TANGIER ISLAND
Pocomoke Sound
Chesapeake Bay
LEGEND
OWNERSHIP
Federal
Non-Federal Public
Private-All unmarked shoreline private.
USE
Public Recreational
Private Recreational
Non-Recreational
Undeveloped
Potomac River
NOTES:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
2. Information shown by symbols has been generalized and is based on the best available data.
KING GEORGE CO.
Rosier Cr.
POTOMAC BEACH
COLONIAL BEACH
Mattox Cr.
Popes Cr.
MUSES BEACH
WESTMORELAND STATE PARK
WESTMORELAND CO.
NOMINI BAY
Nomini Cr.
Lower Machodoc Cr.
Hampton Hall Br.
Coan R.
NORTHUMBERLAND CO.
Wicomico River
INGRAM BAY
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
VIRGINIA
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
5
0
5

PLATE 12

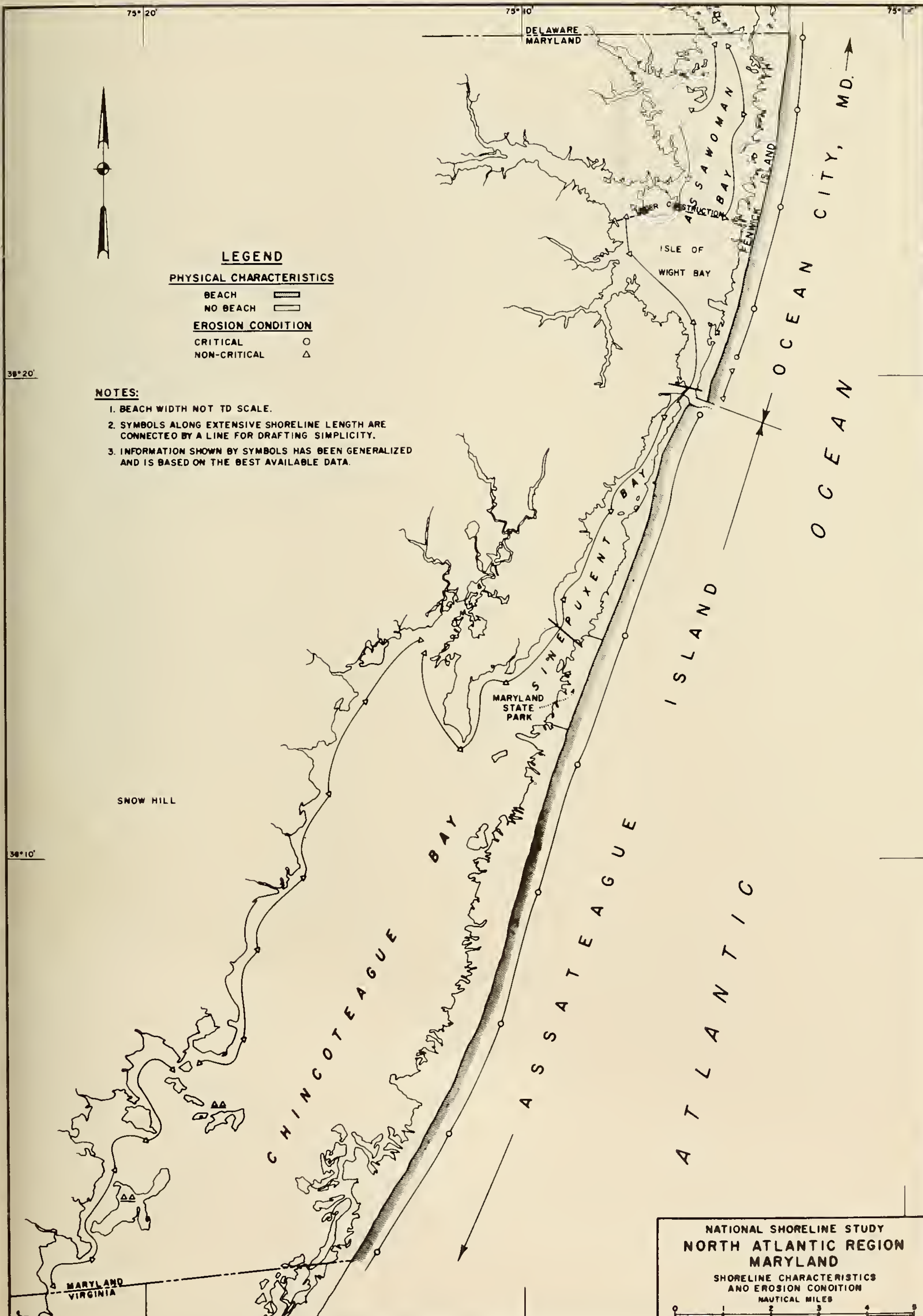
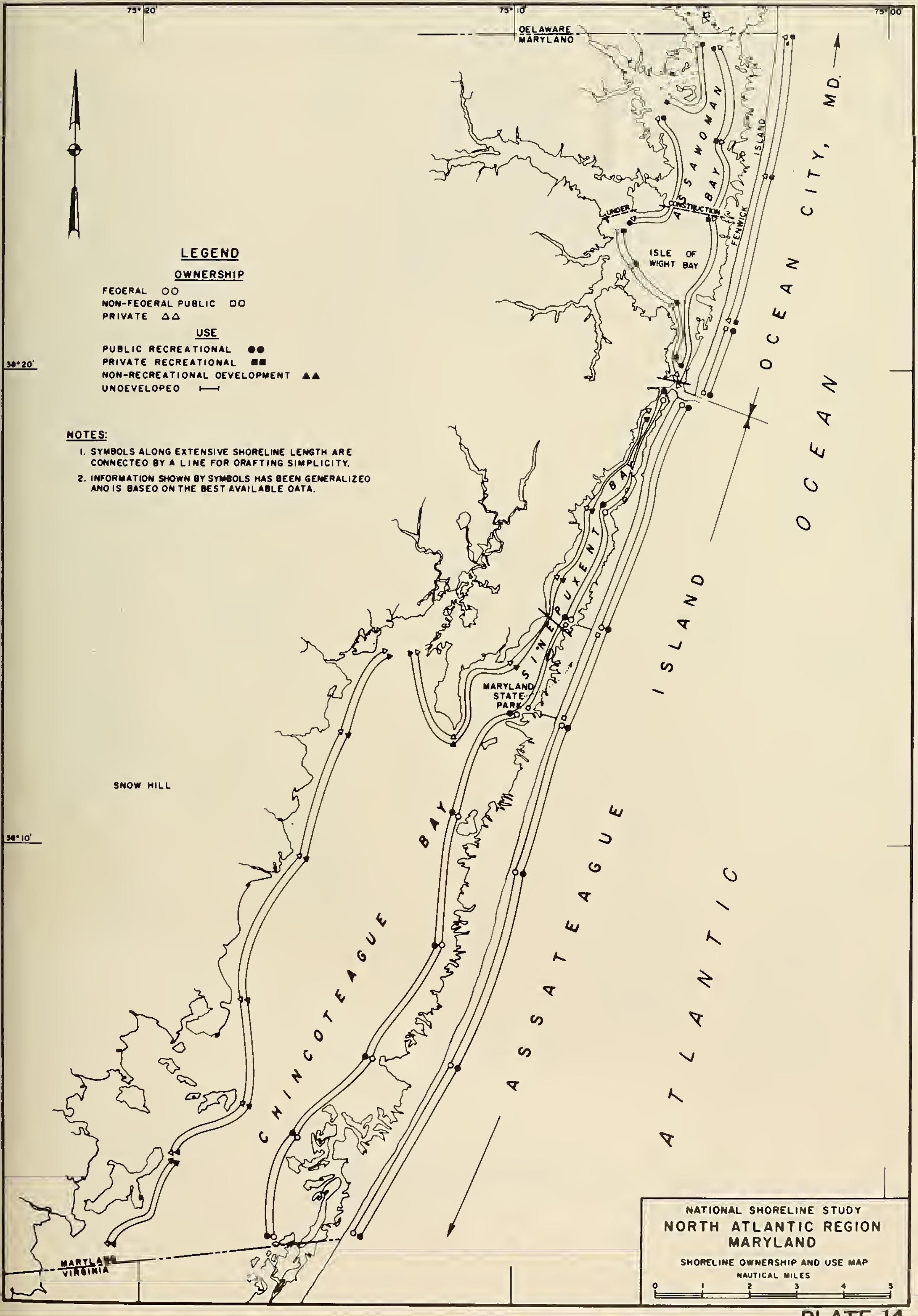

75° 20'
75° 10'
DELAWARE
MARYLAND
LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
NOTES:
1. BEACH WIDTH NOT TO SCALE.
2. SYMBOLS ALONG EXTENSIVE SHORELINE LENGTH ARE CONNECTED BY A LINE FOR DRAFTING SIMPLICITY.
3. INFORMATION SHOWN BY SYMBOLS HAS BEEN GENERALIZED AND IS BASED ON THE BEST AVAILABLE DATA.
38° 20'
38° 10'
ASSAWOMAN BAY
FENWICK ISLAND
ISLE OF WIGHT BAY
OCEAN CITY, MD.
SINEPUXENT BAY
MARYLAND STATE PARK
SNOW HILL
CHINCOTEAGUE BAY
ASSATEAGUE ISLAND
ATLANTIC OCEAN
MARYLAND
VIRGINIA
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MARYLAND
SHORELINE CHARACTERISTICS AND EROSION CONDITION
NAUTICAL MILES
0 1 2 3 4 5

PLATE 13



75° 20'
75° 10'
75° 00'
DELAWARE
MARYLAND
38° 20'
38° 10'
LEGEND
OWNERSHIP
FEDERAL
NON-FEDERAL PUBLIC
PRIVATE
USE
PUBLIC RECREATIONAL
PRIVATE RECREATIONAL
NON-RECREATIONAL DEVELOPMENT
UNDEVELOPED
NOTES:
1. SYMBOLS ALONG EXTENSIVE SHORELINE LENGTH ARE CONNECTED BY A LINE FOR DRAFTING SIMPLICITY.
2. INFORMATION SHOWN BY SYMBOLS HAS BEEN GENERALIZED AND IS BASED ON THE BEST AVAILABLE DATA.
ASSAWOMAN BAY
FENWICK ISLAND
UNDER CONSTRUCTION
ISLE OF WIGHT BAY
OCEAN CITY, MD.
SINEPUXENT BAY
MARYLAND STATE PARK
SNOW HILL
CHINCOTEAGUE BAY
ASSATEAGUE ISLAND
ATLANTIC OCEAN
MARYLAND
VIRGINIA
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MARYLAND
SHORELINE OWNERSHIP AND USE MAP
NAUTICAL MILES
0 1 2 3 4 5

PLATE 14

LEGEND

PHYSICAL CHARACTERISTICS

BEACH

NO BEACH

EROSION CONDITION

CRITICAL ○

NON-CRITICAL △

NOTES:

1. BEACH WIDTH NOT TO SCALE.
2. SYMBOLS ALONG EXTENSIVE SHORELINE LENGTH ARE CONNECTED BY A LINE FOR DRAFTING SIMPLICITY.
3. INFORMATION SHOWN BY SYMBOLS HAS BEEN GENERALIZED AND IS BASED ON THE BEST AVAILABLE DATA.

NATIONAL SHORELINE STUDY

NORTH ATLANTIC REGION

MARYLAND

SHORELINE CHARACTERISTICS AND EROSION CONDITION

NAUTICAL MILES 0 5 10

LEGEND

OWNERSHIP

FEDERAL ○○
NON-FEDERAL PUBLIC □□
PRIVATE △△

USE

PUBLIC RECREATIONAL ●●
PRIVATE RECREATIONAL ■■
NON-RECREATIONAL DEVELOPMENT ▲▲
UNDEVELOPED ├─┤

NOTES:

1. SYMBOLS ALONG EXTENSIVE SHORELINE LENGTH ARE CONNECTED BY A LINE FOR DRAFTING SIMPLICITY.
2. INFORMATION SHOWN BY SYMBOLS HAS BEEN GENERALIZED AND IS BASED ON THE BEST AVAILABLE DATA.

NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MARYLAND
SHORELINE OWNERSHIP AND USE MAP
NAUTICAL MILES
0 5 10

NOTES:

1. BEACH WIDTH NOT TO SCALE.
2. SYMBOLS ALONG EXTENSIVE SHORELINE LENGTH ARE CONNECTED BY A LINE FOR DRAFTING SIMPLICITY.
3. INFORMATION SHOWN BY SYMBOLS HAS BEEN GENERALIZED AND IS BASED ON THE BEST AVAILABLE DATA.
4. CROSS HATCHED AREAS REPRESENT HEAVY URBAN DEVELOPMENT.

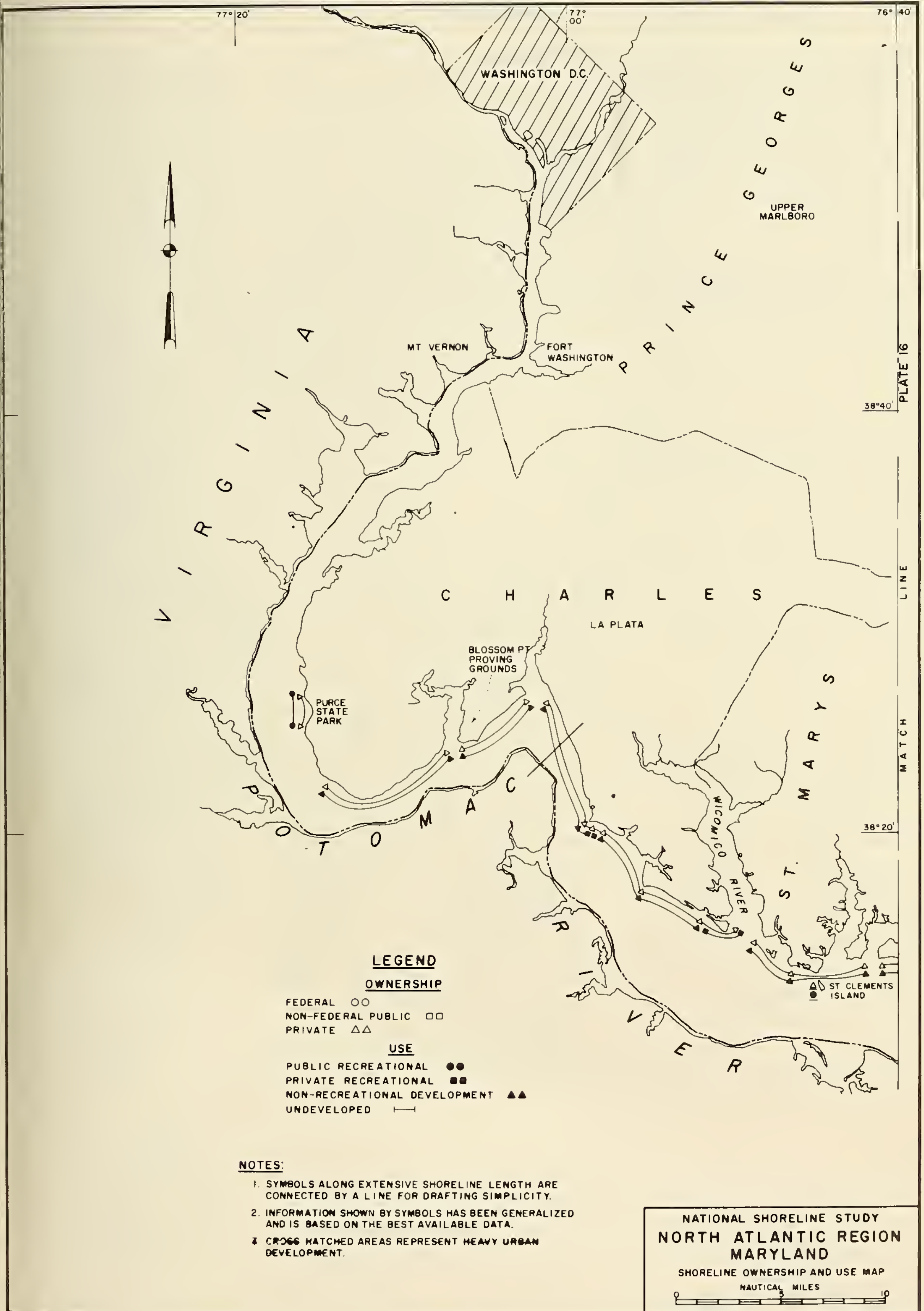
NATIONAL SHORELINE STUDY

NORTH ATLANTIC REGION
MARYLAND

SHORELINE CHARACTERISTICS AND EROSION CONDITION

NAUTICAL MILES
0 5 10

PLATE 17



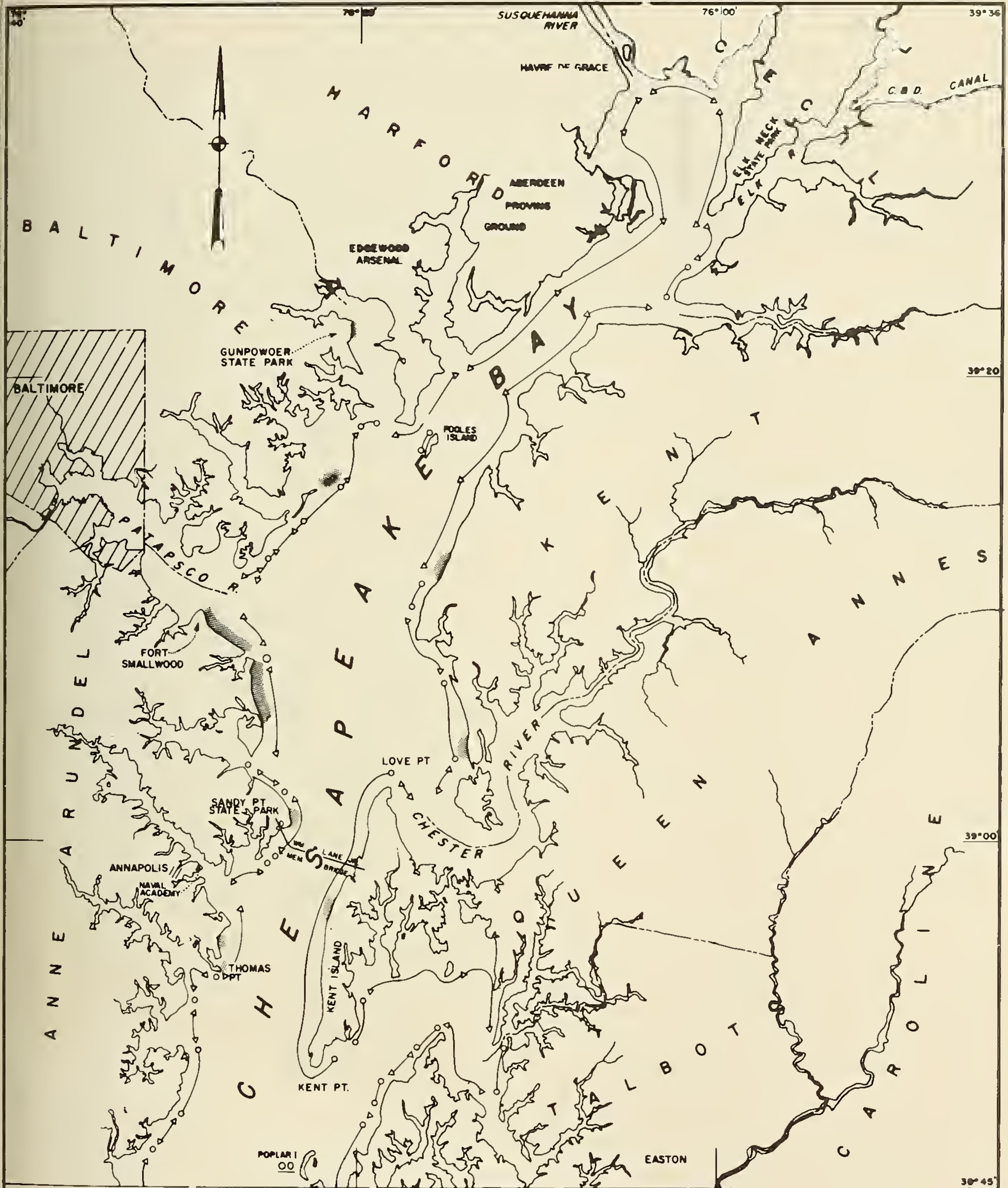
NATIONAL SHORELINE STUDY

NORTH ATLANTIC REGION
MARYLAND

SHORELINE OWNERSHIP AND USE MAP

NAUTICAL MILES 0 5 10

PLATE 18



LEGEND

PHYSICAL CHARACTERISTICS

- BEACH
- NO BEACH

EROSION CONDITION

- CRITICAL ○
- NON-CRITICAL △

NOTES:

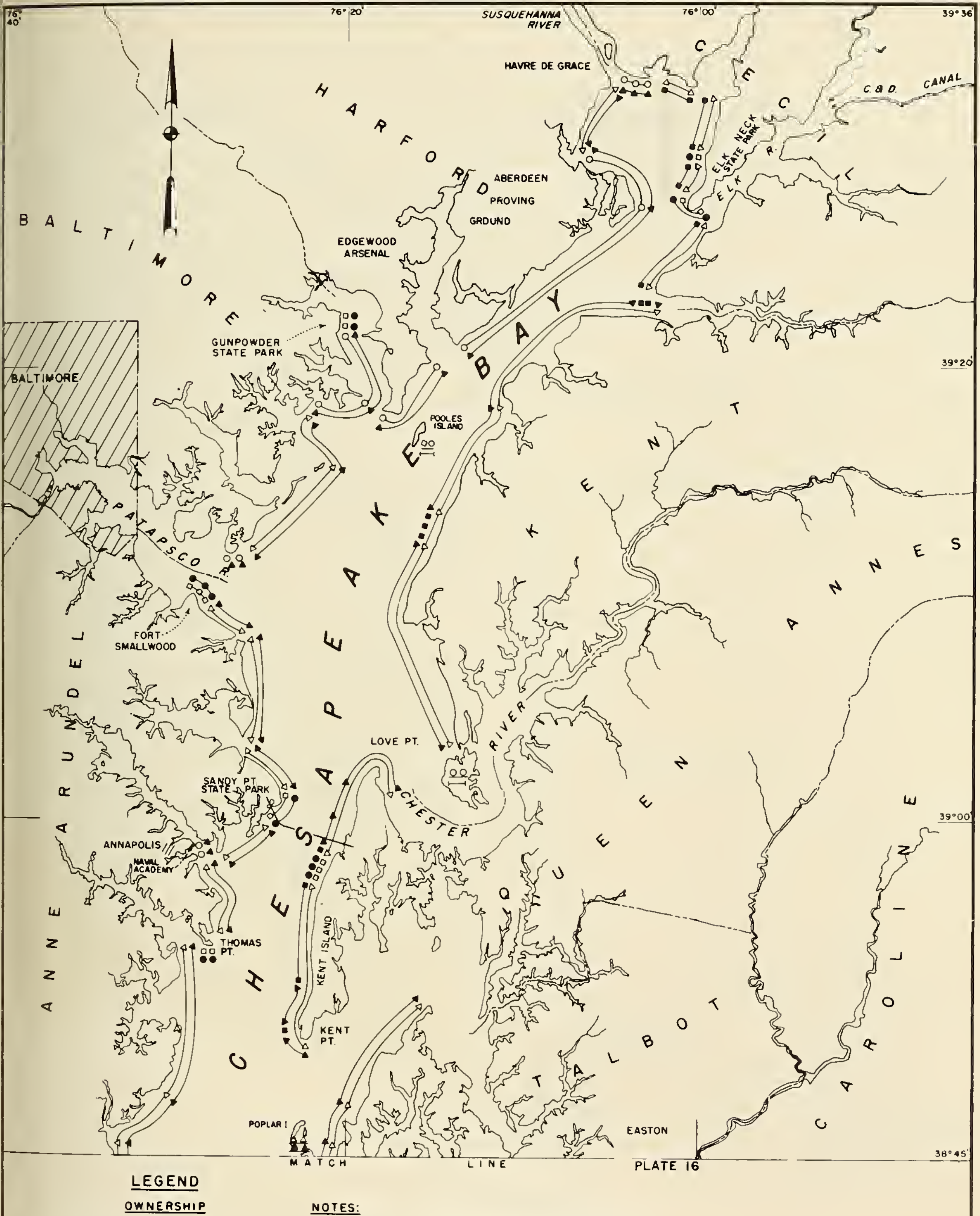
1. BEACH WIDTH NOT TO SCALE.
2. SYMBOLS ALONG EXTENSIVE SHORELINE LENGTH ARE CONNECTED BY A LINE FOR DRAFTING SIMPLICITY.
3. INFORMATION SHOWN BY SYMBOLS HAS BEEN GENERALIZED AND IS BASED ON THE BEST AVAILABLE DATA.
4. CROSS HATCHED AREAS REPRESENT HEAVY URBAN DEVELOPMENT.

NATIONAL SHORELINE STUDY

NORTH ATLANTIC REGION
MARYLAND

SHORELINE CHARACTERISTICS AND EROSION CONDITION

NAUTICAL MILES 0 5 10



LEGEND

OWNERSHIP

FEDERAL ○○
NON-FEDERAL PUBLIC □□
PRIVATE △△

USE

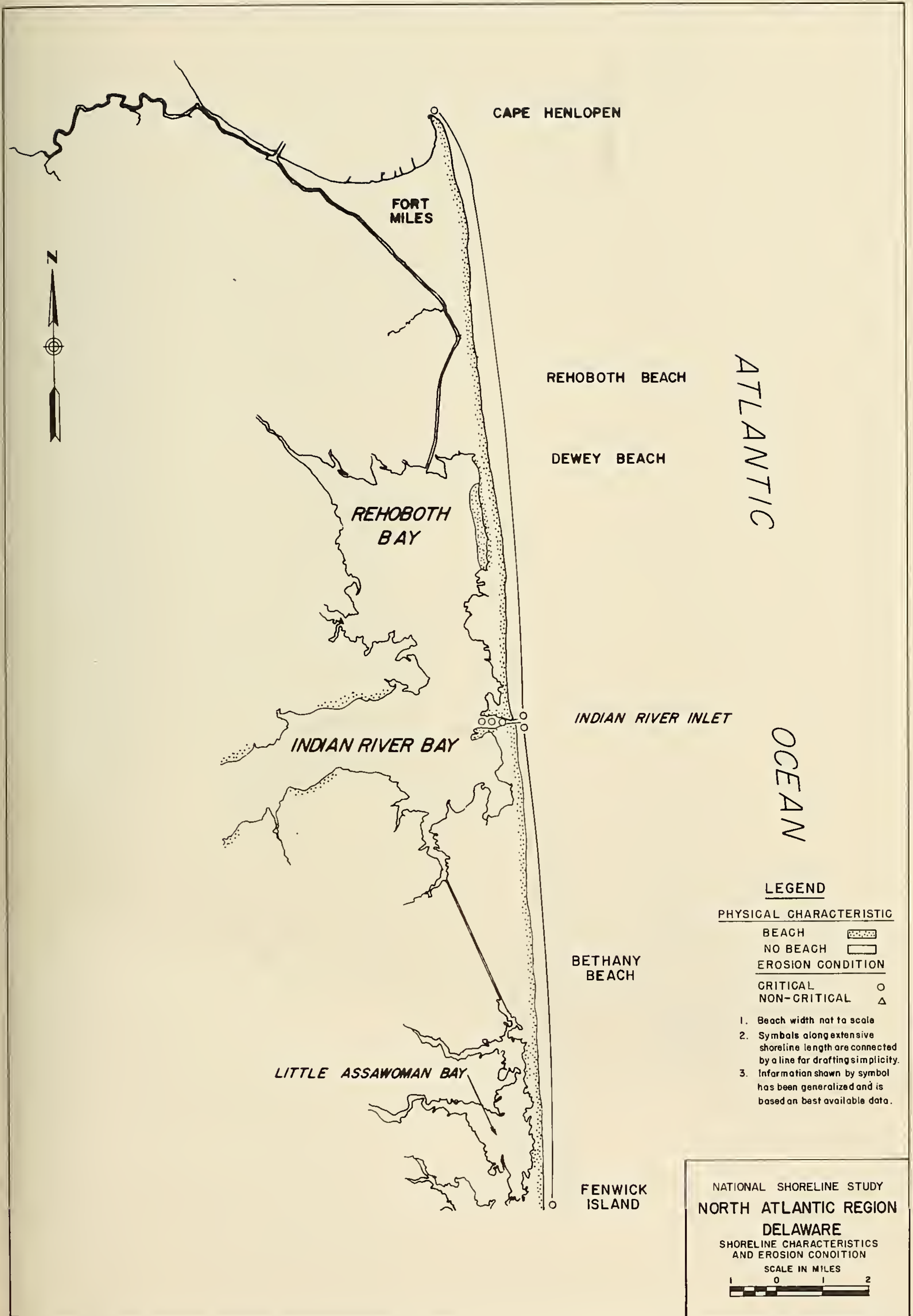
PUBLIC RECREATIONAL ●●
PRIVATE RECREATIONAL ■■
NON-RECREATIONAL DEVELOPMENT ▲▲
UNDEVELOPED |—|

NOTES:

1. SYMBOLS ALONG EXTENSIVE SHORELINE LENGTH ARE CONNECTED BY A LINE FOR DRAFTING SIMPLICITY.
2. INFORMATION SHOWN BY SYMBOLS HAS BEEN GENERALIZED AND IS BASED ON THE BEST AVAILABLE DATA.
3. CROSS HATCHED AREAS REPRESENT HEAVY URBAN DEVELOPMENT.

NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MARYLAND
SHORELINE OWNERSHIP AND USE MAP
NAUTICAL MILES
0 5 10

PLATE 20



CAPE HENLOPEN
FORT MILES
N
REHOBOTH BEACH
DEWEY BEACH
ATLANTIC
REHOBOTH BAY
INDIAN RIVER INLET
INDIAN RIVER BAY
OCEAN
BETHANY BEACH
LITTLE ASSAWOMAN BAY
FENWICK ISLAND
LEGEND
PHYSICAL CHARACTERISTIC
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
1. Beach width not to scale
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbol has been generalized and is based on best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
DELAWARE
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2

PLATE 21

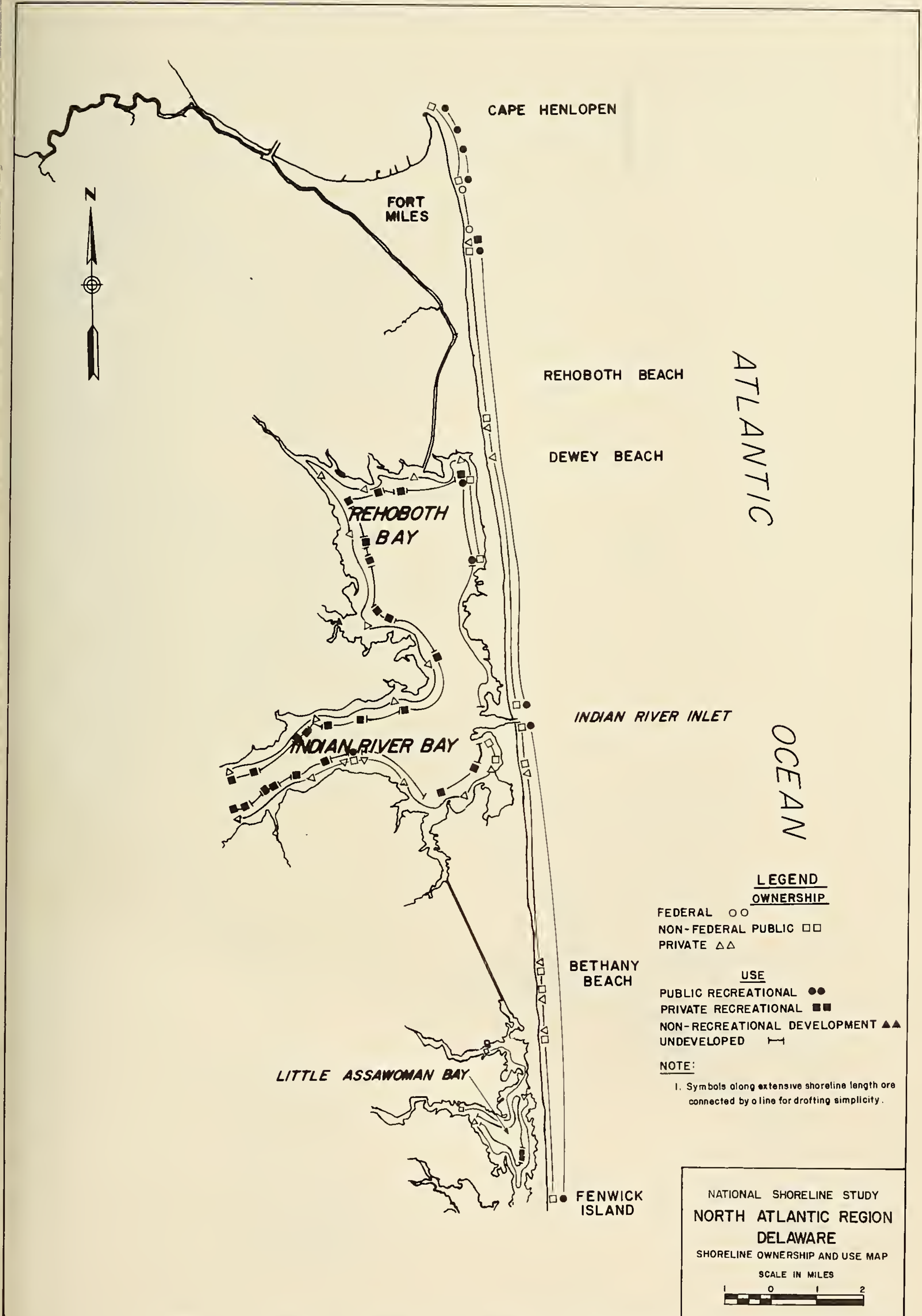

CAPE HENLOPEN
FORT MILES
N
REHOBOTH BEACH
DEWEY BEACH
ATLANTIC
OCEAN
REHOBOTH BAY
INDIAN RIVER INLET
INDIAN RIVER BAY
BETHANY BEACH
LITTLE ASSAWOMAN BAY
FENWICK ISLAND
LEGEND
OWNERSHIP
FEDERAL ○○
NON-FEDERAL PUBLIC □□
PRIVATE △△
USE
PUBLIC RECREATIONAL ●●
PRIVATE RECREATIONAL ■■
NON-RECREATIONAL DEVELOPMENT ▲▲
UNDEVELOPED
NOTE:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
DELAWARE
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2

PLATE 22

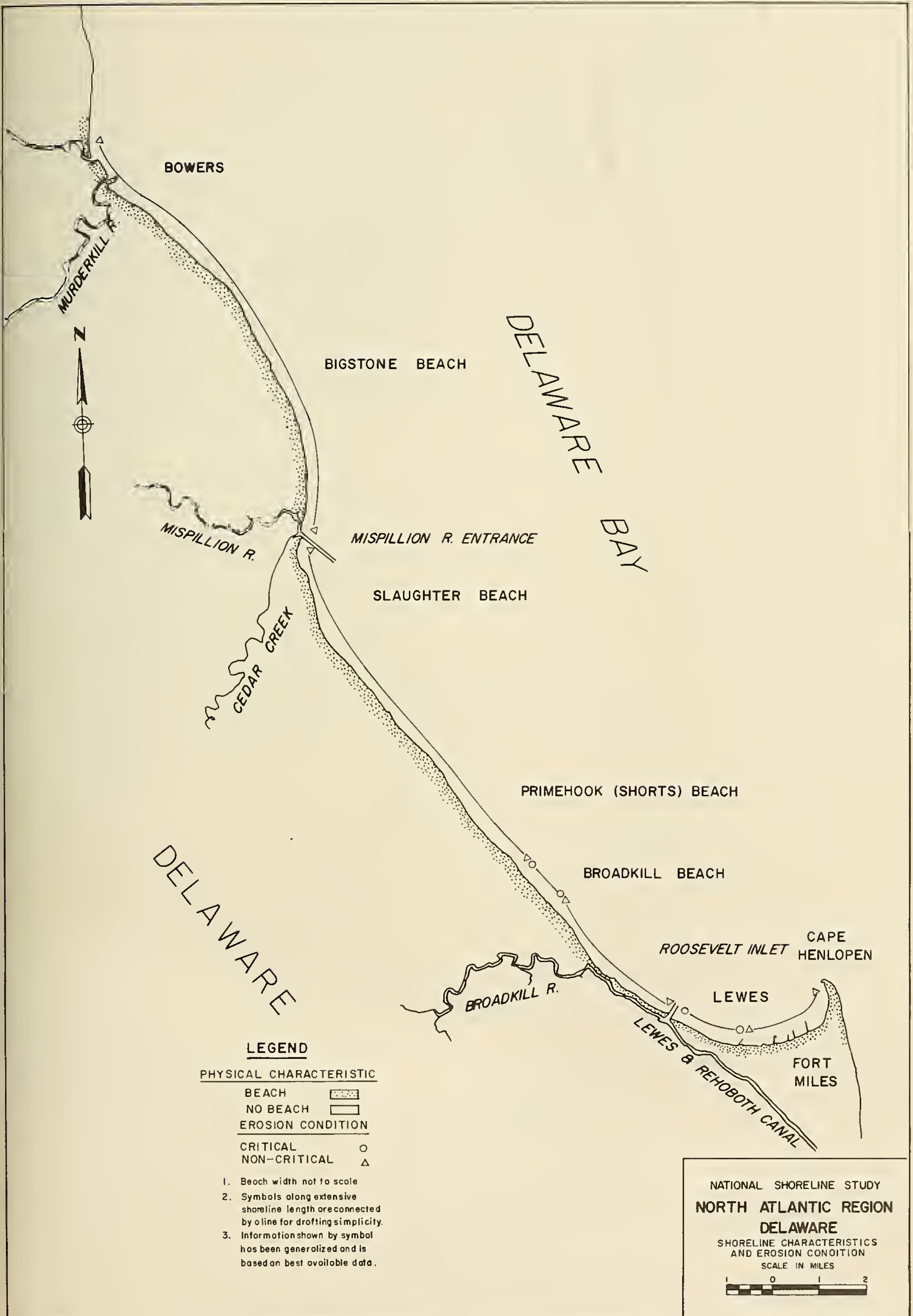
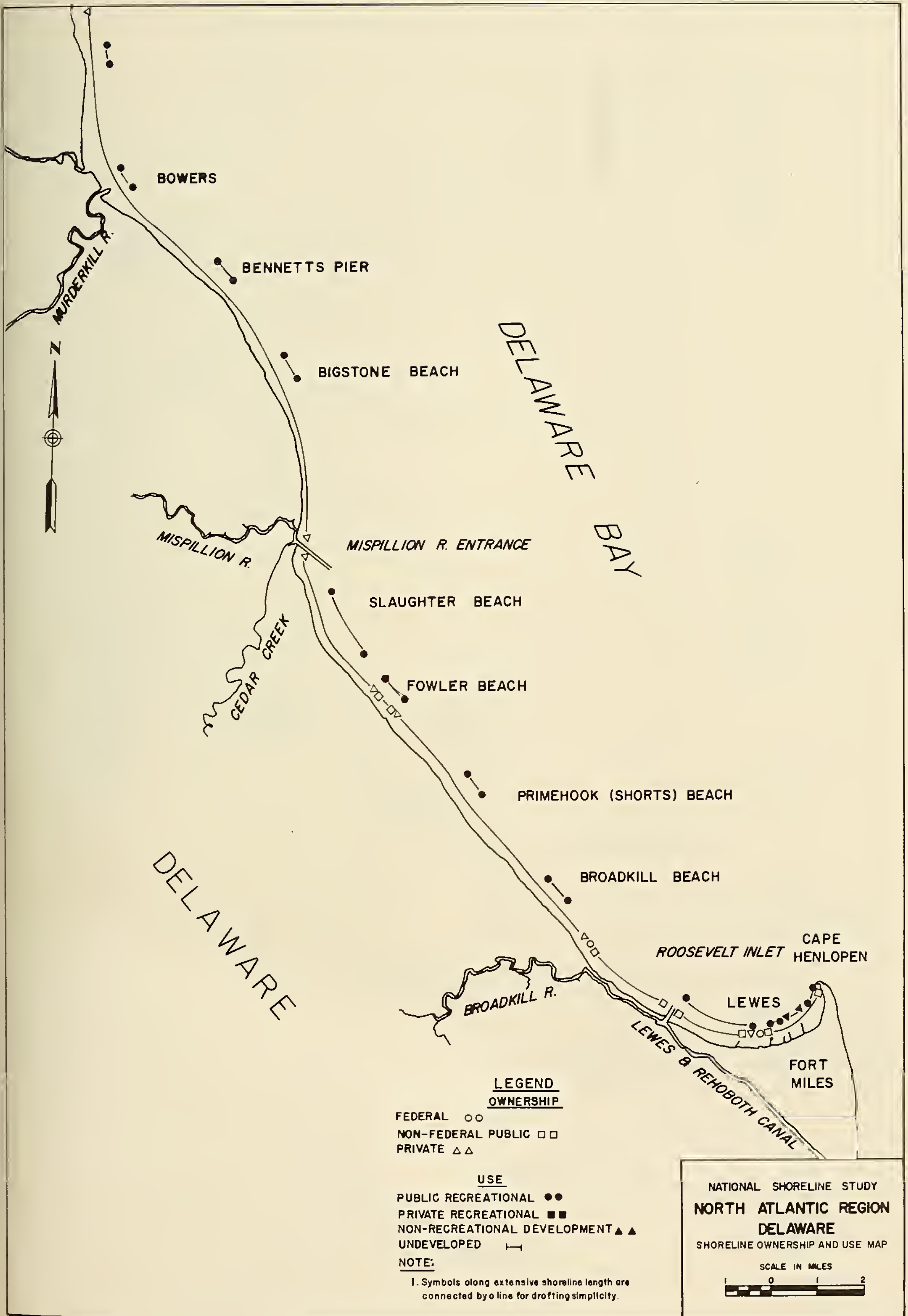

BOWERS
MURDERKILL R.
N
BIGSTONE BEACH
DELAWARE BAY
MISPILLION R.
MISPILLION R. ENTRANCE
SLAUGHTER BEACH
CEDAR CREEK
PRIMEHOOK (SHORTS) BEACH
BROADKILL BEACH
DELAWARE
ROOSEVELT INLET
CAPE HENLOPEN
LEWES
BROADKILL R.
LEWES & REHOBOTH CANAL
FORT MILES
LEGEND
PHYSICAL CHARACTERISTIC
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
1. Beach width not to scale
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbol has been generalized and is based on best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
DELAWARE
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2

PLATE 23



BOWERS
MURDERKILL R.
BENNETTS PIER
N
BIGSTONE BEACH
DELAWARE BAY
MISPILLION R.
MISPILLION R. ENTRANCE
SLAUGHTER BEACH
CEDAR CREEK
FOWLER BEACH
PRIMEHOOK (SHORTS) BEACH
DELAWARE
BROADKILL BEACH
ROOSEVELT INLET
CAPE HENLOPEN
BROADKILL R.
LEWES
LEWES & REHOBOTH CANAL
FORT MILES
LEGEND
OWNERSHIP
FEDERAL
NON-FEDERAL PUBLIC
PRIVATE
USE
PUBLIC RECREATIONAL
PRIVATE RECREATIONAL
NON-RECREATIONAL DEVELOPMENT
UNDEVELOPED
NOTE:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
DELAWARE
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2

PLATE 24

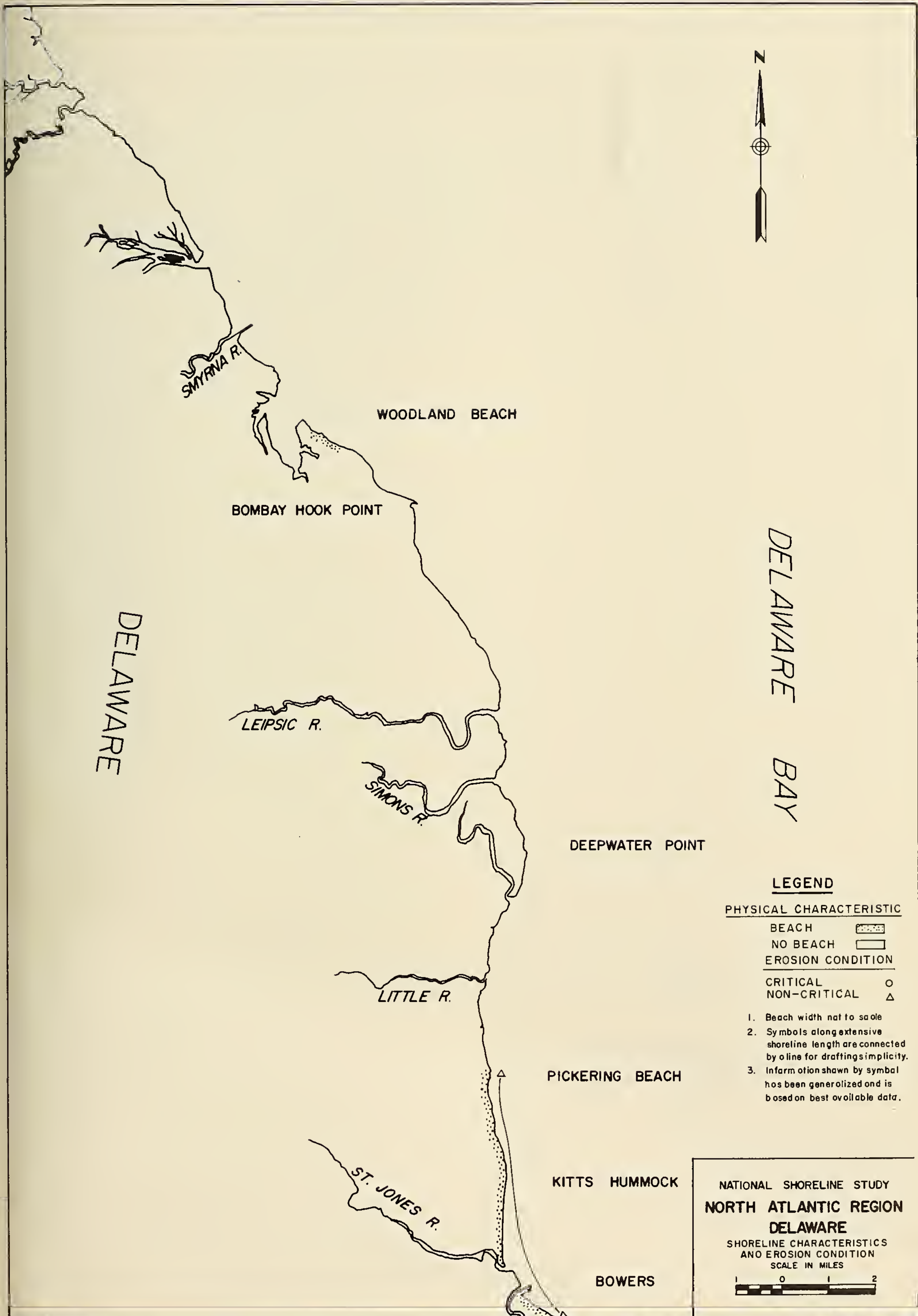
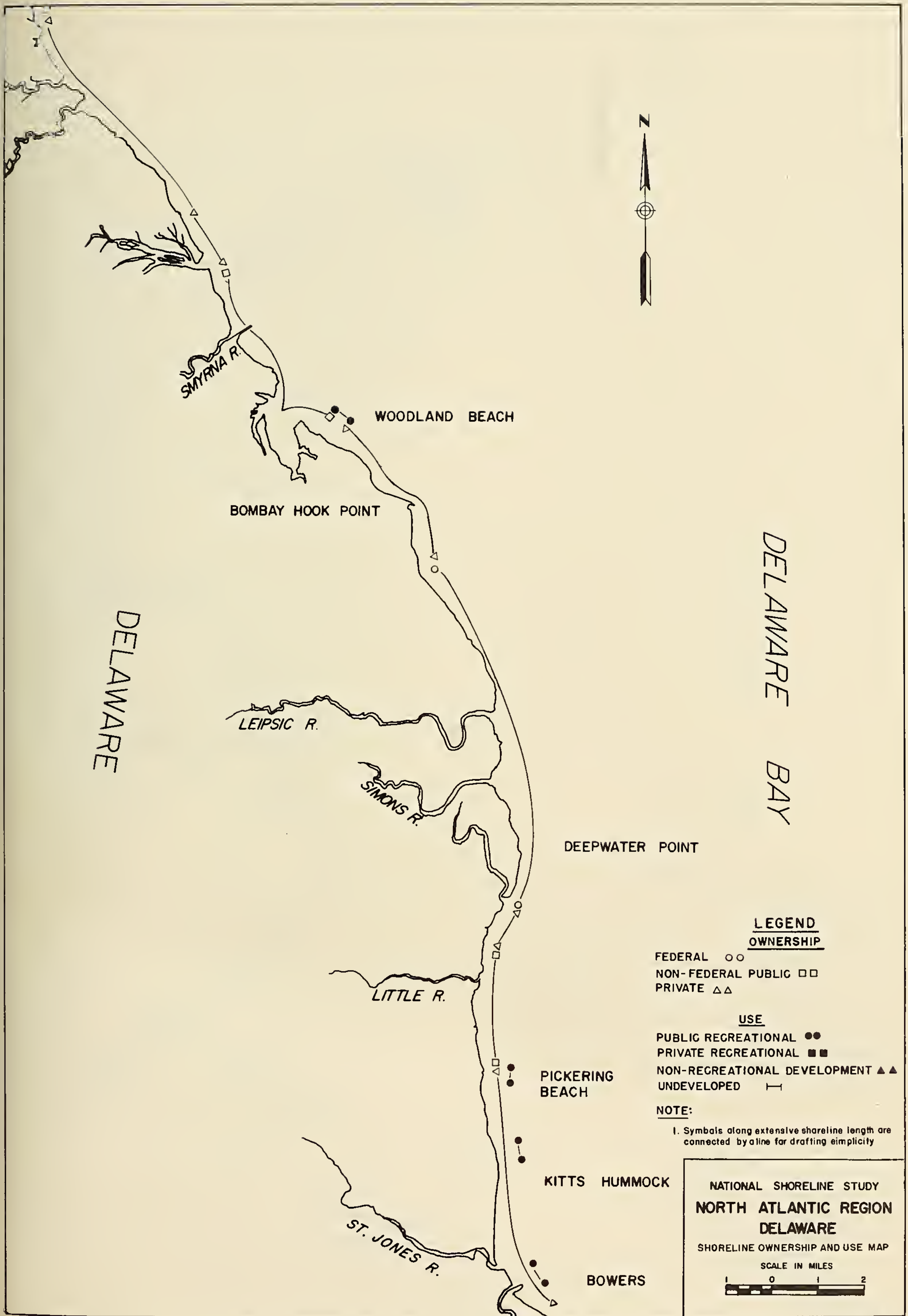
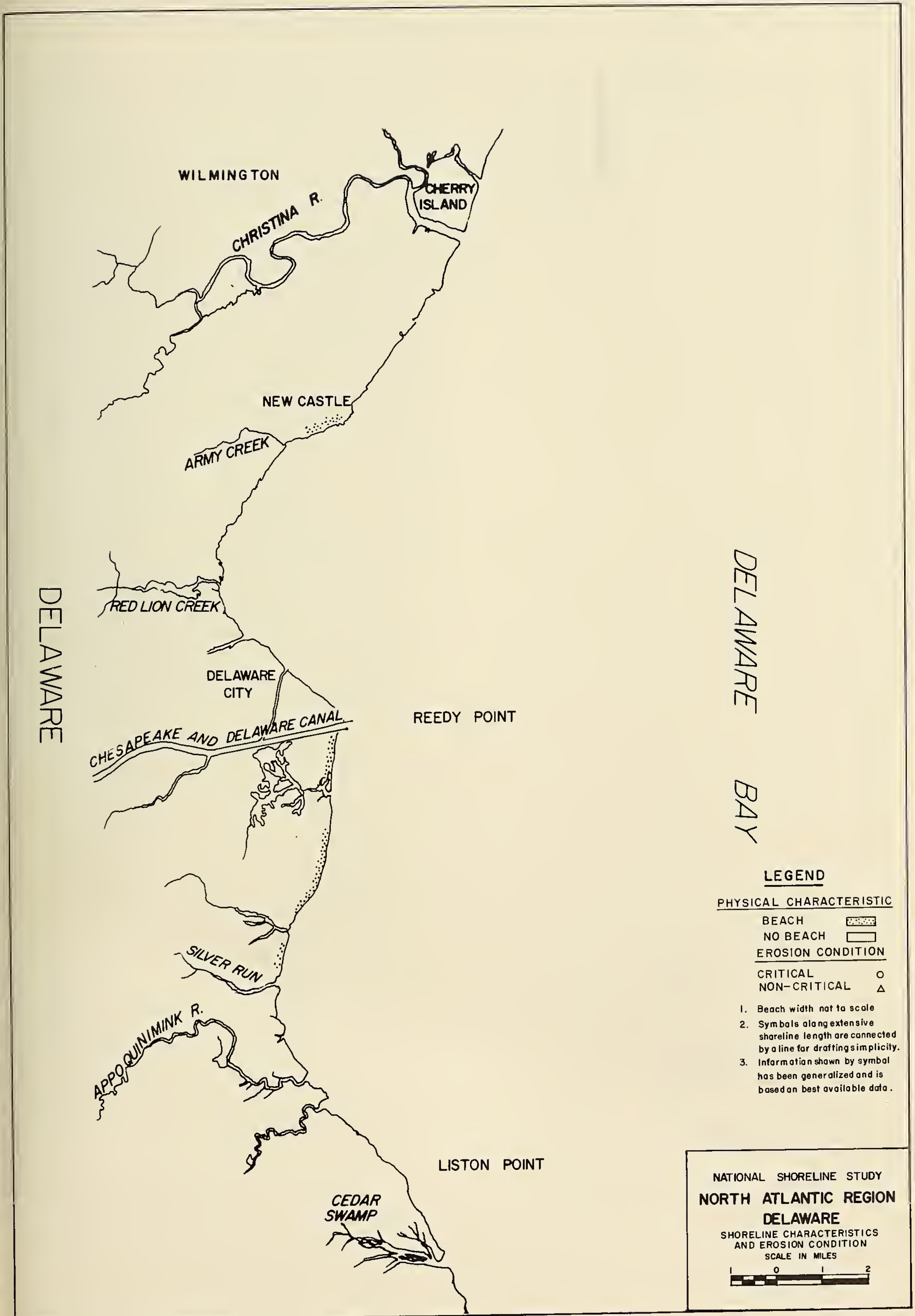

N
SMYRNA R.
WOODLAND BEACH
BOMBAY HOOK POINT
DELAWARE
DELAWARE BAY
LEIPSIC R.
SIMONS R.
DEEPWATER POINT
LITTLE R.
PICKERING BEACH
ST. JONES R.
KITTS HUMMOCK
BOWERS
LEGEND
PHYSICAL CHARACTERISTIC
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
1. Beach width not to scale
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbol has been generalized and is based on best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
DELAWARE
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2

PLATE 25



N
SMYRNA R.
WOODLAND BEACH
BOMBAY HOOK POINT
DELAWARE
DELAWARE BAY
LEIPSIC R.
SIMONS R.
DEEPWATER POINT
LITTLE R.
PICKERING BEACH
KITTS HUMMOCK
ST. JONES R.
BOWERS
LEGEND
OWNERSHIP
FEDERAL
NON-FEDERAL PUBLIC
PRIVATE
USE
PUBLIC RECREATIONAL
PRIVATE RECREATIONAL
NON-RECREATIONAL DEVELOPMENT
UNDEVELOPED
NOTE:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
DELAWARE
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2

PLATE 26



WILMINGTON
CHRISTINA R.
CHERRY ISLAND
NEW CASTLE
ARMY CREEK
RED LION CREEK
DELAWARE
DELAWARE CITY
CHESAPEAKE AND DELAWARE CANAL
REEDY POINT
DELAWARE BAY
SILVER RUN
APPOQUINIMINK R.
LISTON POINT
CEDAR SWAMP
LEGEND
PHYSICAL CHARACTERISTIC
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
1. Beach width not to scale
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbol has been generalized and is based on best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
DELAWARE
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2

PLATE 27

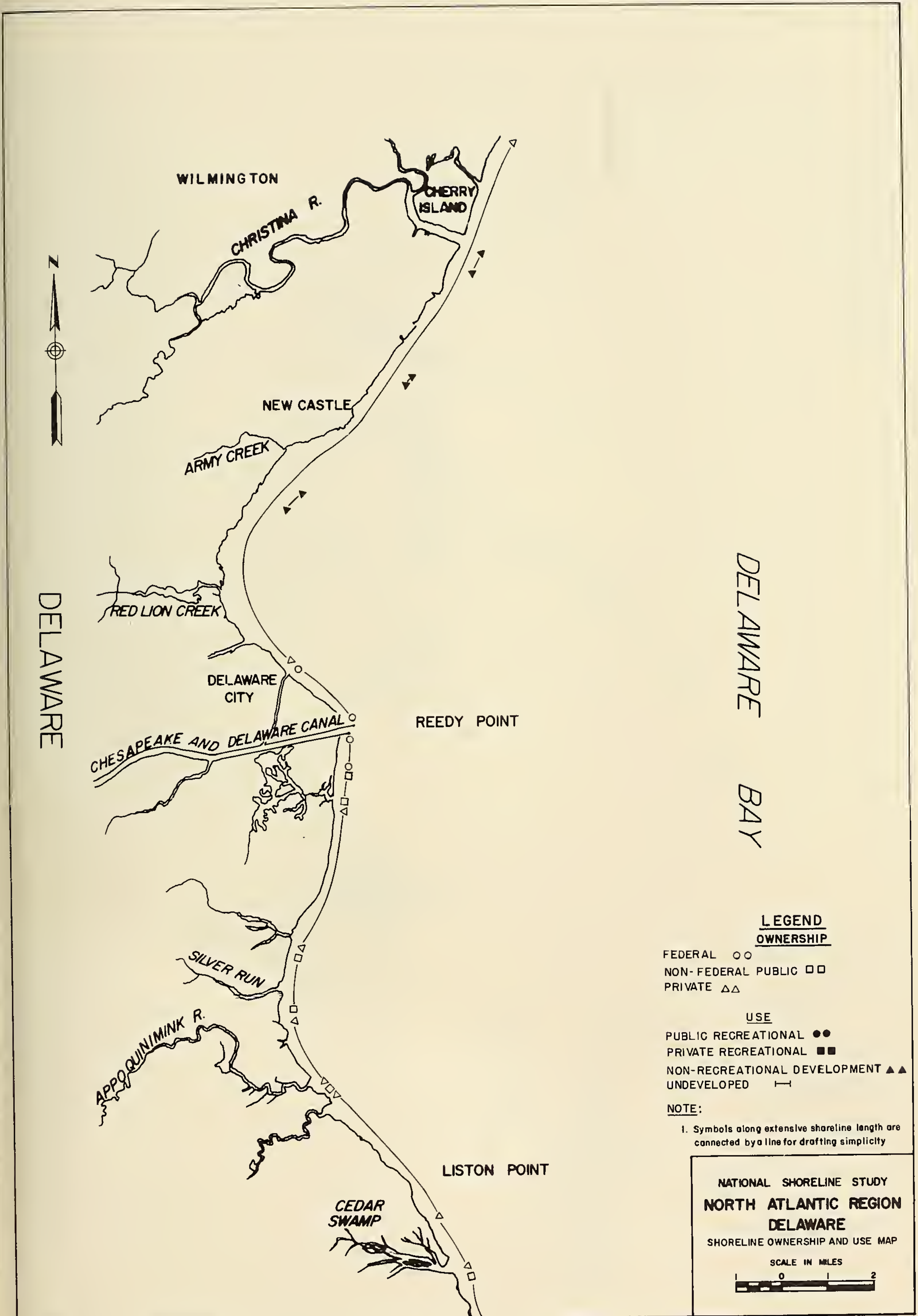

WILMINGTON
CHRISTINA R.
CHERRY ISLAND
NEW CASTLE
ARMY CREEK
RED LION CREEK
DELAWARE CITY
CHESAPEAKE AND DELAWARE CANAL
REEDY POINT
SILVER RUN
APPOQUINIMINK R.
LISTON POINT
CEDAR SWAMP
DELAWARE
DELAWARE BAY
N
LEGEND
OWNERSHIP
FEDERAL ○○
NON-FEDERAL PUBLIC □□
PRIVATE △△
USE
PUBLIC RECREATIONAL ●●
PRIVATE RECREATIONAL ■■
NON-RECREATIONAL DEVELOPMENT ▲▲
UNDEVELOPED
NOTE:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
DELAWARE
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2

PLATE 28

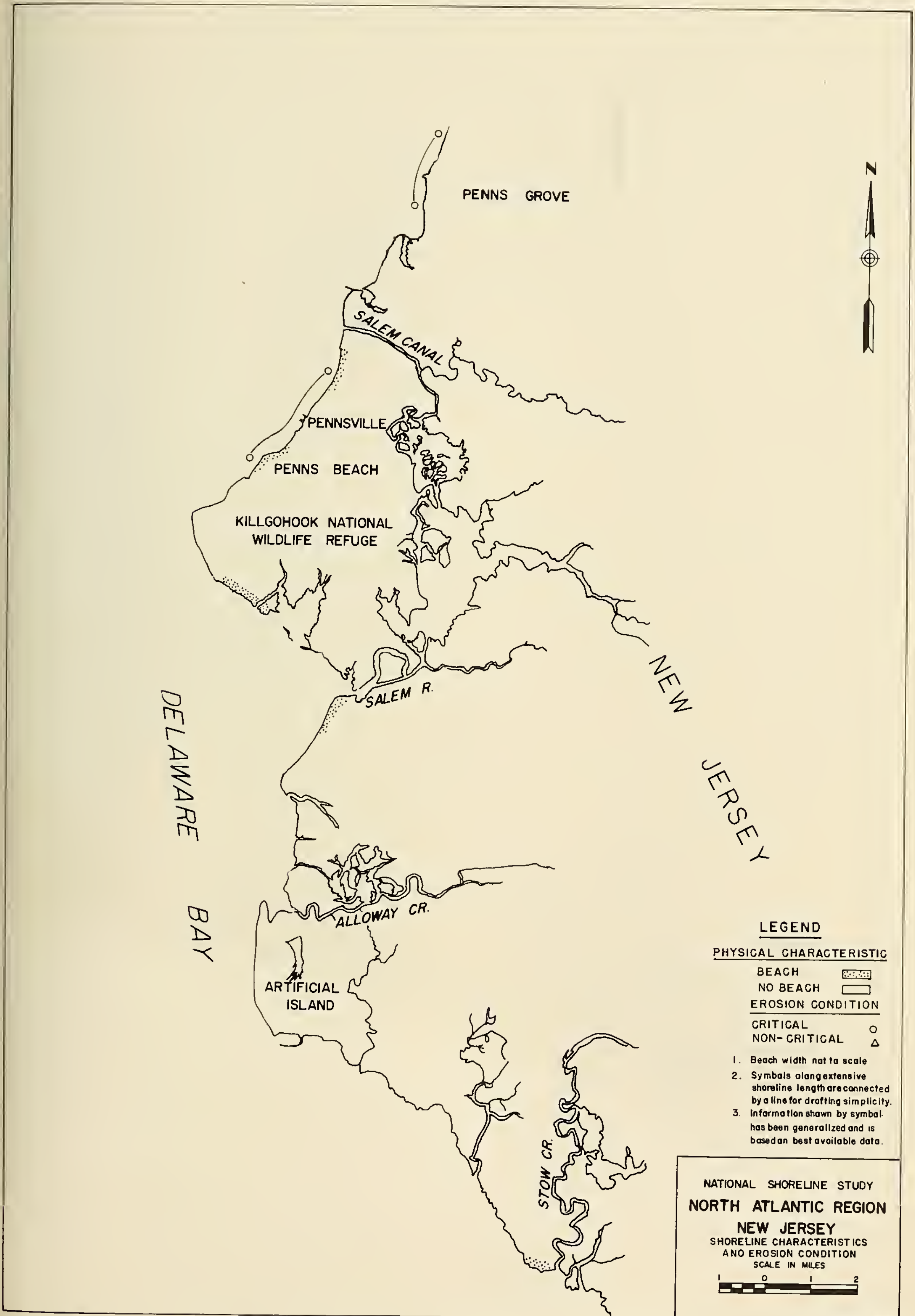
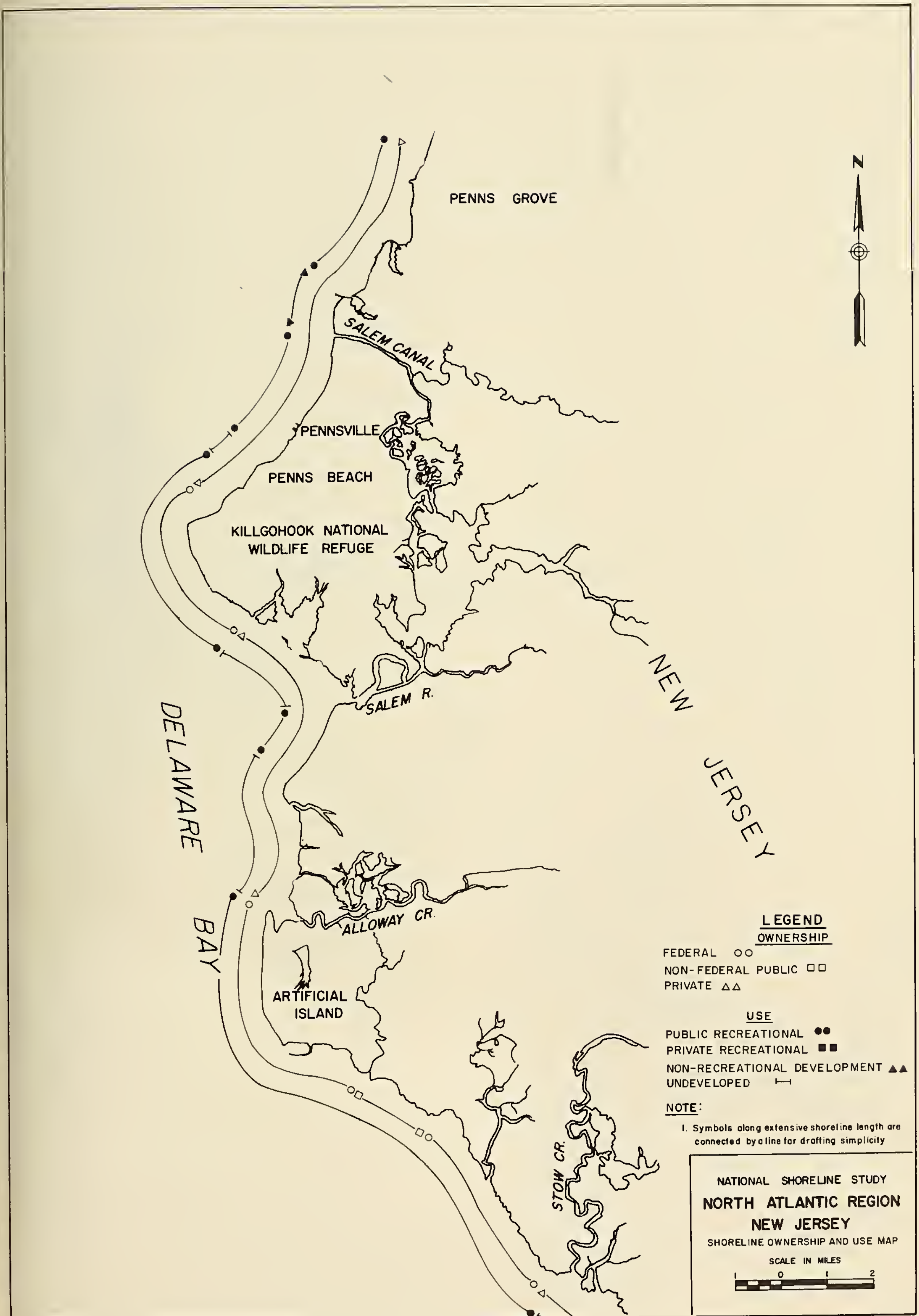
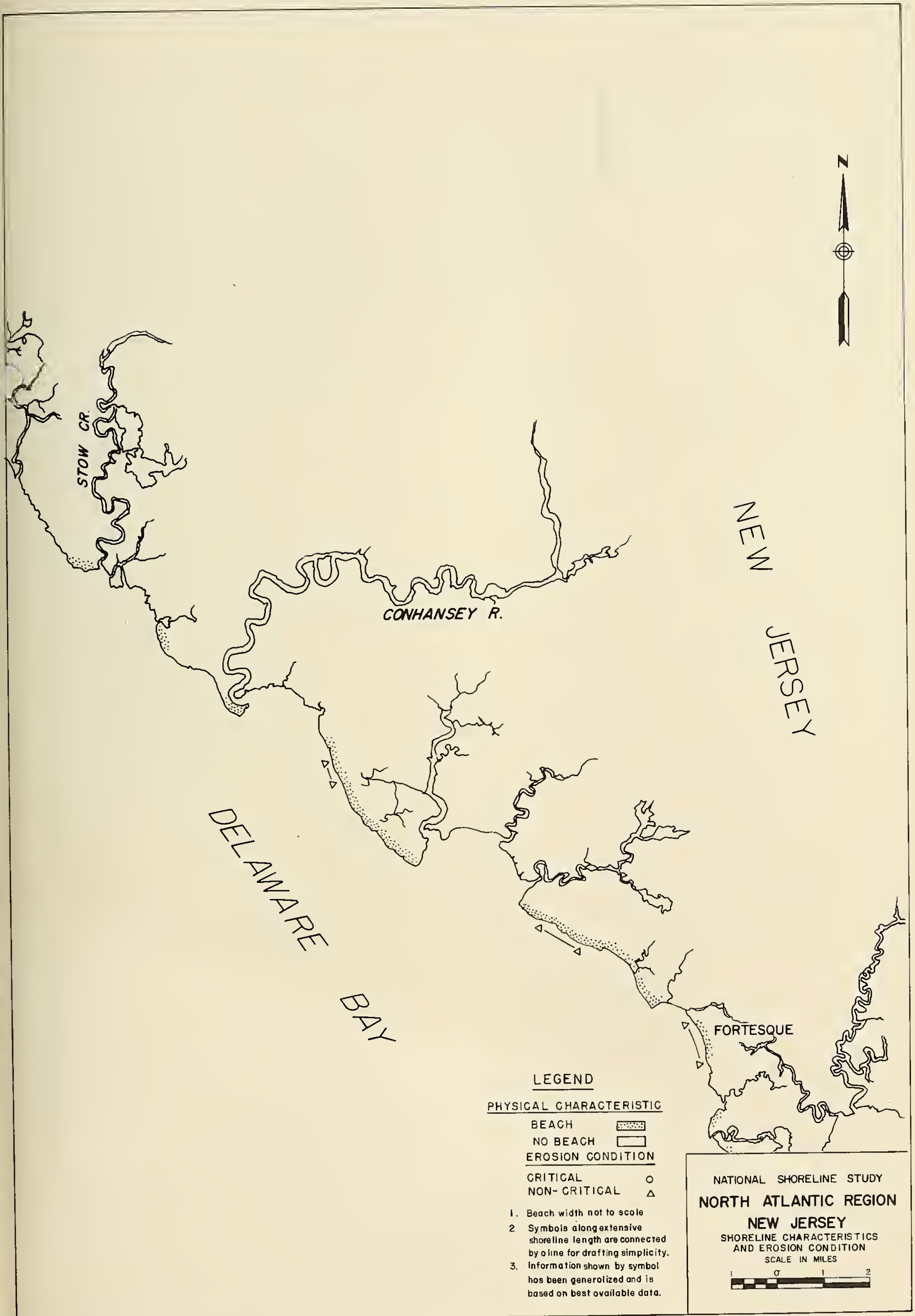

PENNS GROVE
SALEM CANAL
PENNSVILLE
PENNS BEACH
KILLGOHOOK NATIONAL WILDLIFE REFUGE
SALEM R.
DELAWARE BAY
NEW JERSEY
ALLOWAY CR.
ARTIFICIAL ISLAND
STOW CR.
N
LEGEND
PHYSICAL CHARACTERISTIC
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
1. Beach width not to scale
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbol has been generalized and is based on best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2

PLATE 29


PENNS GROVE
SALEM CANAL
PENNSVILLE
PENNS BEACH
KILLGOHOOK NATIONAL
WILDLIFE REFUGE
SALEM R.
NEW JERSEY
DELAWARE BAY
ALLOWAY CR.
ARTIFICIAL ISLAND
STOW CR.
N
LEGEND
OWNERSHIP
FEDERAL
NON-FEDERAL PUBLIC
PRIVATE
USE
PUBLIC RECREATIONAL
PRIVATE RECREATIONAL
NON-RECREATIONAL DEVELOPMENT
UNDEVELOPED
NOTE:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2



STOW CR.
CONHANSEY R.
NEW JERSEY
DELAWARE BAY
FORTESQUE
N
LEGEND
PHYSICAL CHARACTERISTIC
BEACH
NO BEACH
EROSION CONDITION
CRITICAL ○
NON- CRITICAL △
1. Beach width not to scale
2 Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbol has been generalized and is based on best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2

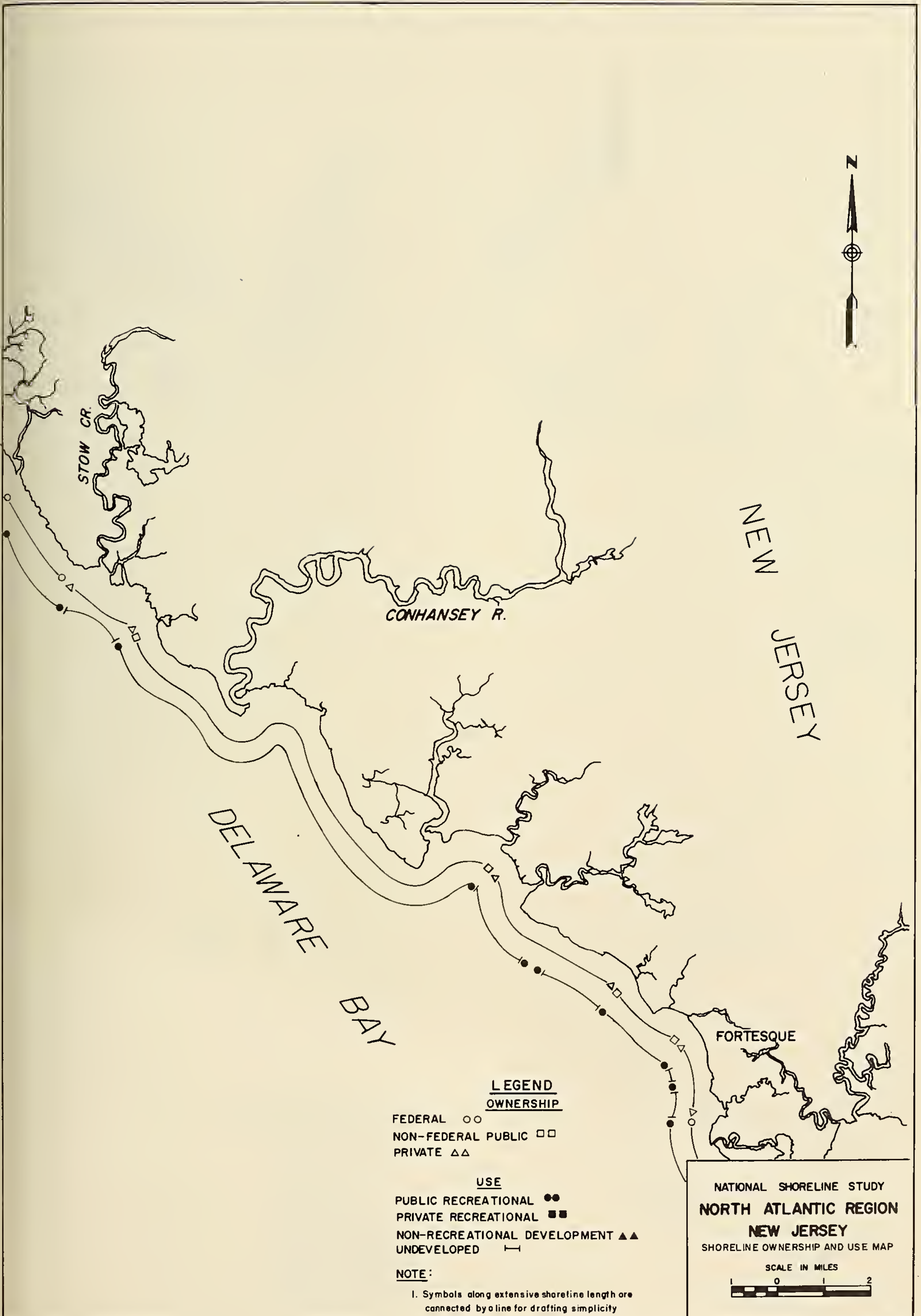

N
STOW CR.
CONHANSEY R.
NEW JERSEY
DELAWARE BAY
FORTESQUE
LEGEND
OWNERSHIP
FEDERAL ○○
NON-FEDERAL PUBLIC □□
PRIVATE △△
USE
PUBLIC RECREATIONAL ●●
PRIVATE RECREATIONAL ■■
NON-RECREATIONAL DEVELOPMENT ▲▲
UNDEVELOPED ⊢⊣
NOTE:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2

PLATE 32

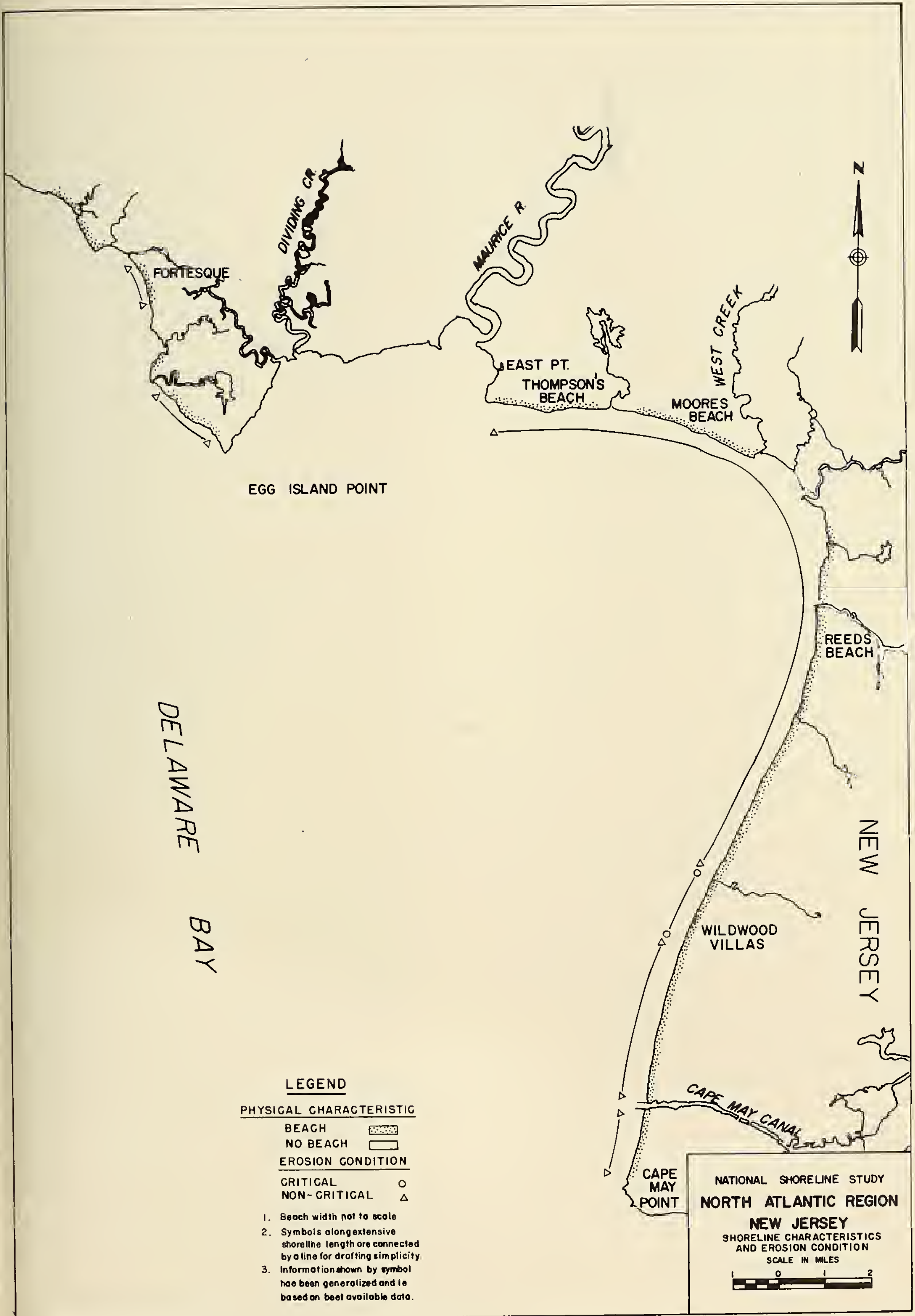
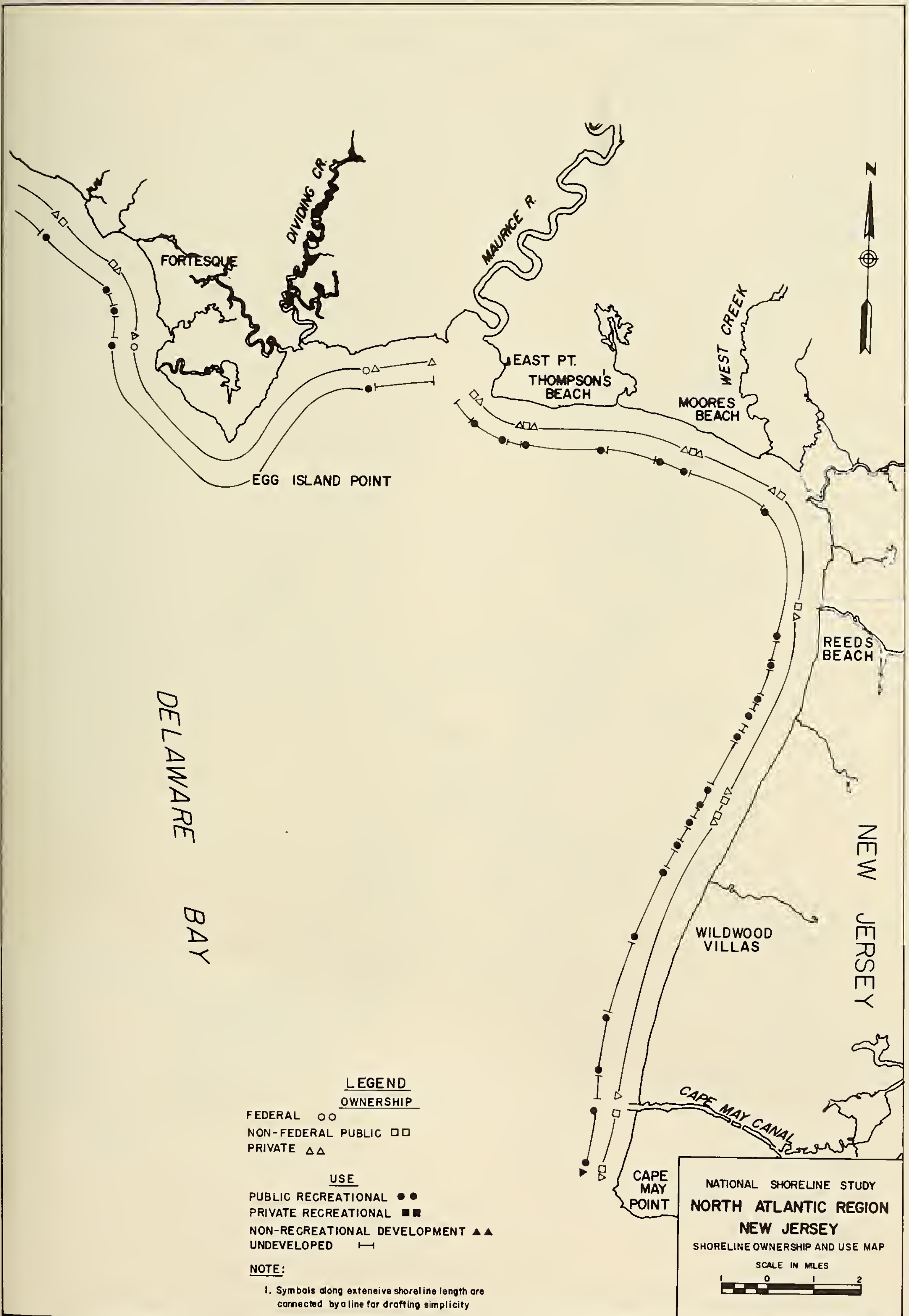
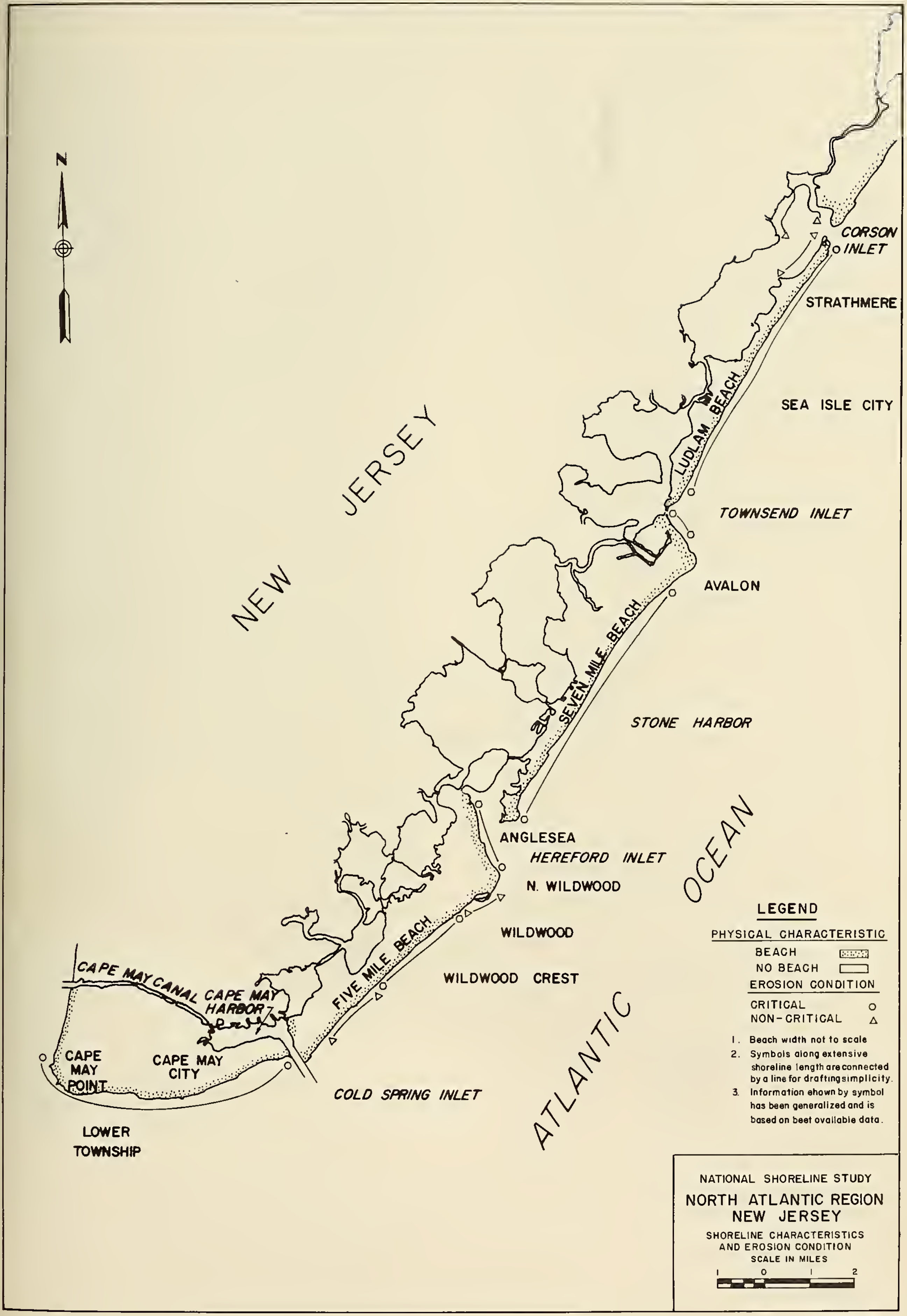

FORTESQUE
DIVIDING CR.
MAURICE R.
EAST PT.
THOMPSON'S BEACH
MOORES BEACH
WEST CREEK
EGG ISLAND POINT
DELAWARE BAY
REEDS BEACH
NEW JERSEY
WILDWOOD VILLAS
CAPE MAY CANAL
CAPE MAY POINT
LEGEND
PHYSICAL CHARACTERISTIC
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
1. Beach width not to scale
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbol has been generalized and is based on best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2

PLATE 33



DIVIDING CR.
FORTESQUE
MAURICE R.
EAST PT.
THOMPSON'S BEACH
WEST CREEK
MOORES BEACH
EGG ISLAND POINT
DELAWARE BAY
REEDS BEACH
NEW JERSEY
WILDWOOD VILLAS
CAPE MAY CANAL
CAPE MAY POINT
N
LEGEND
OWNERSHIP
FEDERAL ○○
NON-FEDERAL PUBLIC □□
PRIVATE △△
USE
PUBLIC RECREATIONAL ●●
PRIVATE RECREATIONAL ■■
NON-RECREATIONAL DEVELOPMENT ▲▲
UNDEVELOPED ⊢⊣
NOTE:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2

PLATE 34


N
NEW JERSEY
CORSON INLET
STRATHMERE
LUDLAM BEACH
SEA ISLE CITY
TOWNSEND INLET
AVALON
SEVEN MILE BEACH
STONE HARBOR
ANGLESEA
HEREFORD INLET
N. WILDWOOD
WILDWOOD
WILDWOOD CREST
FIVE MILE BEACH
CAPE MAY CANAL
CAPE MAY HARBOR
CAPE MAY POINT
CAPE MAY CITY
COLD SPRING INLET
LOWER TOWNSHIP
ATLANTIC OCEAN
LEGEND
PHYSICAL CHARACTERISTIC
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
1. Beach width not to scale
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbol has been generalized and is based on best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2

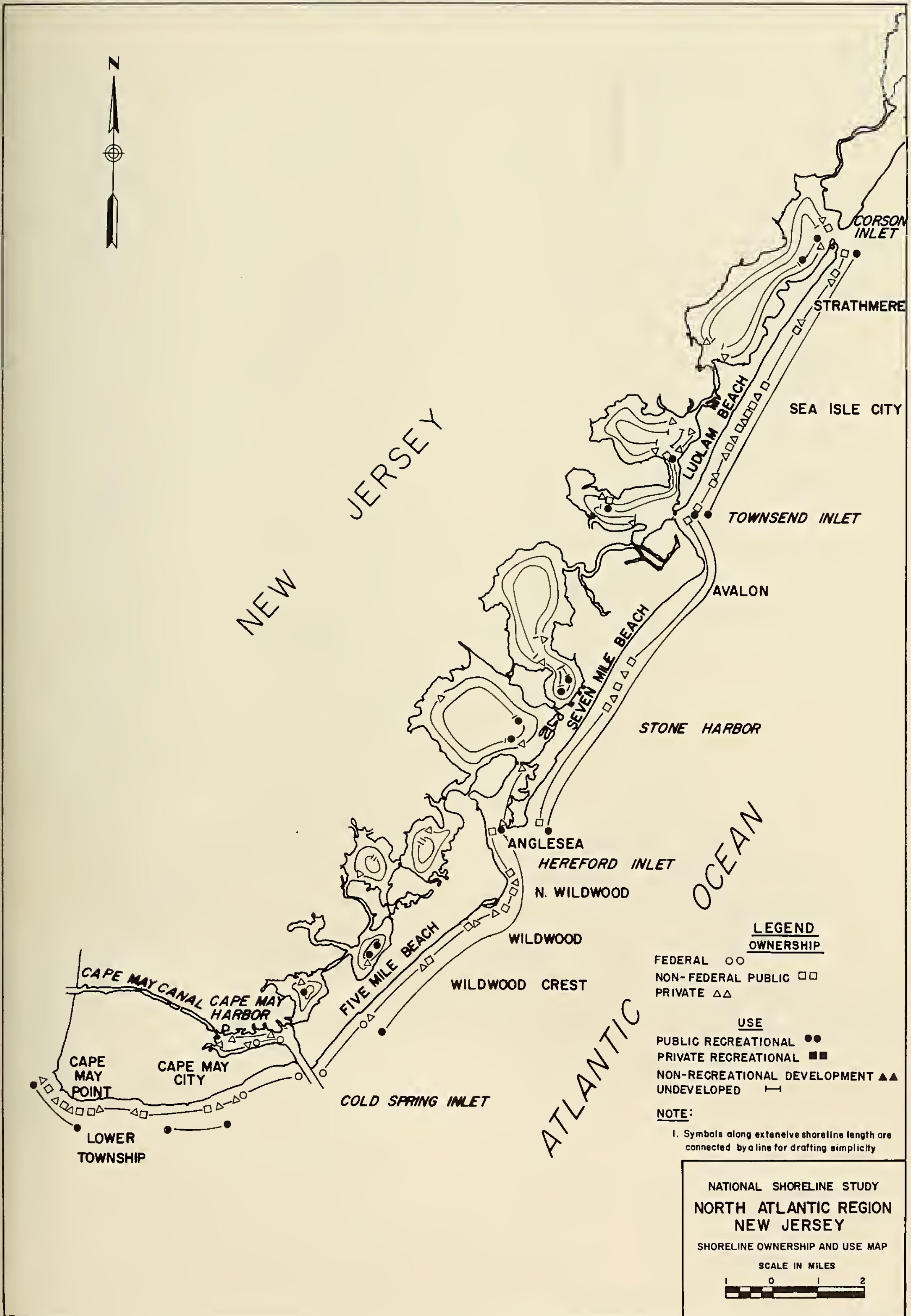

N
NEW JERSEY
CORSON INLET
STRATHMERE
SEA ISLE CITY
LUDLAM BEACH
TOWNSEND INLET
AVALON
SEVEN MILE BEACH
STONE HARBOR
ANGLESEA
HEREFORD INLET
N. WILDWOOD
WILDWOOD
WILDWOOD CREST
FIVE MILE BEACH
CAPE MAY CANAL
CAPE MAY HARBOR
CAPE MAY POINT
CAPE MAY CITY
LOWER TOWNSHIP
COLD SPRING INLET
ATLANTIC OCEAN
LEGEND
OWNERSHIP
FEDERAL ○○
NON-FEDERAL PUBLIC □□
PRIVATE △△
USE
PUBLIC RECREATIONAL ●●
PRIVATE RECREATIONAL ■■
NON-RECREATIONAL DEVELOPMENT ▲▲
UNDEVELOPED
NOTE:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2

PLATE 36

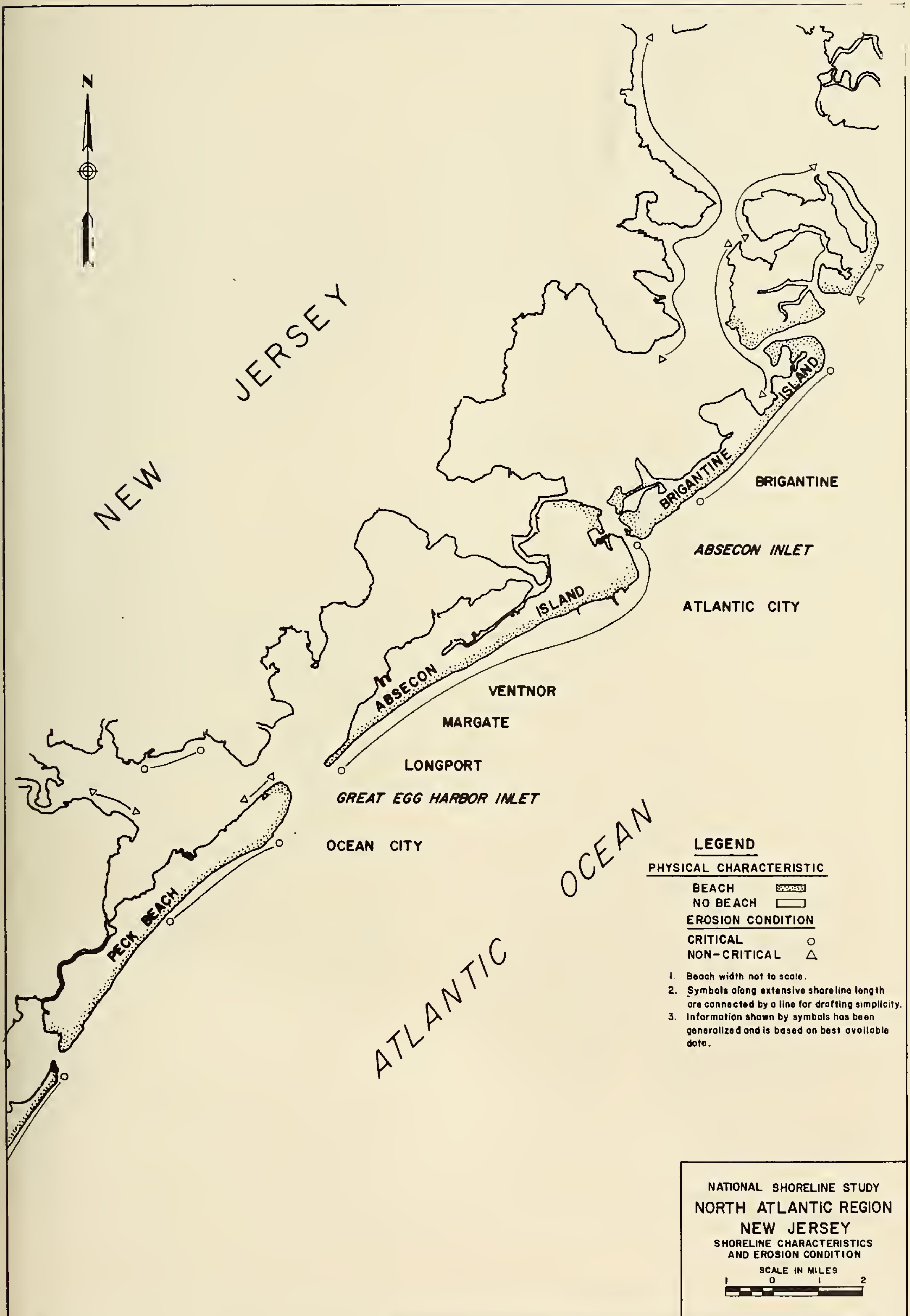

N
NEW JERSEY
BRIGANTINE ISLAND
BRIGANTINE
ABSECON INLET
ATLANTIC CITY
ABSECON ISLAND
VENTNOR
MARGATE
LONGPORT
GREAT EGG HARBOR INLET
OCEAN CITY
PECK BEACH
ATLANTIC OCEAN
LEGEND
PHYSICAL CHARACTERISTIC
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE CHARACTERISTICS
AND EROSION CONDITION
SCALE IN MILES
1 0 1 2

PLATE 37

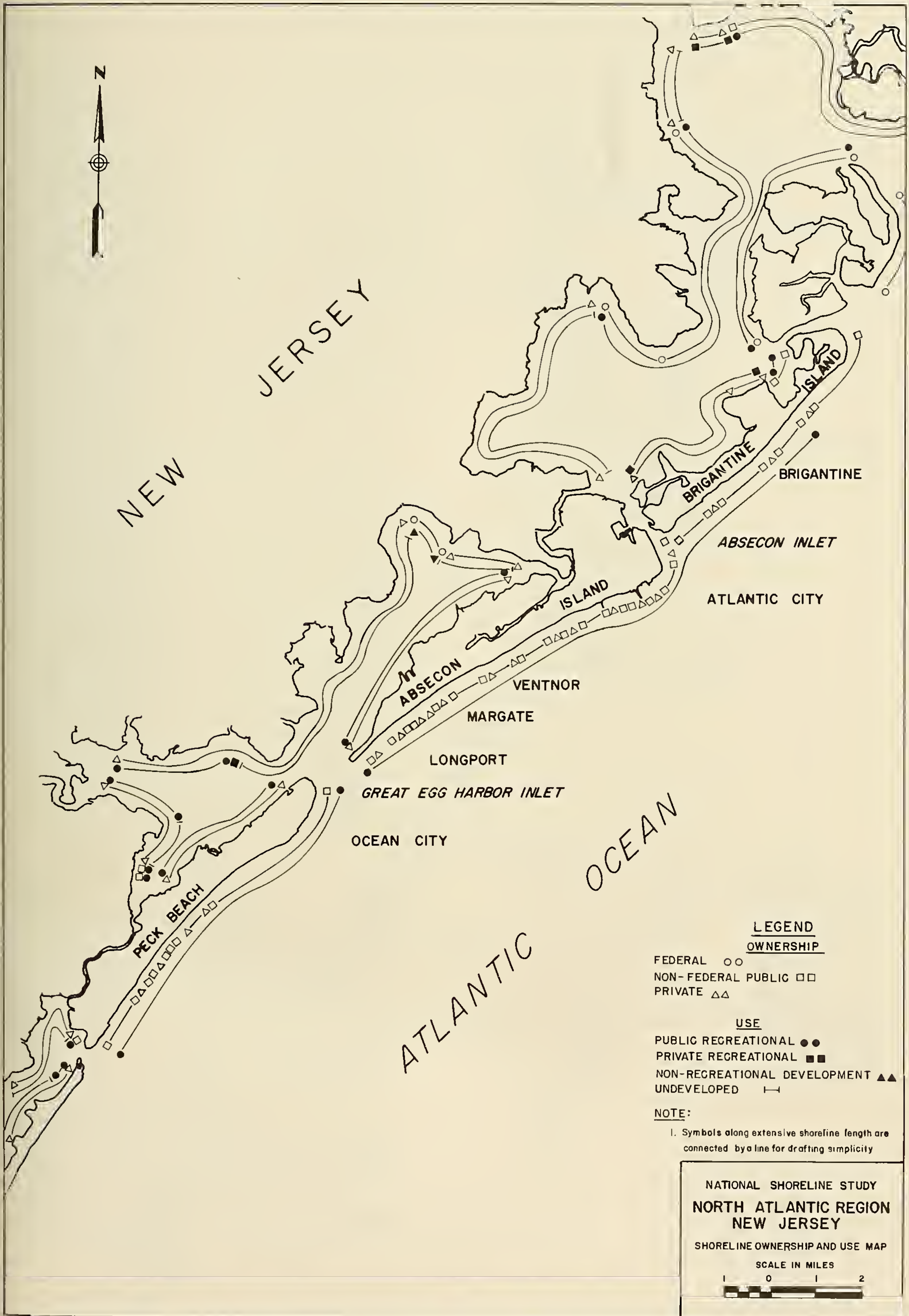
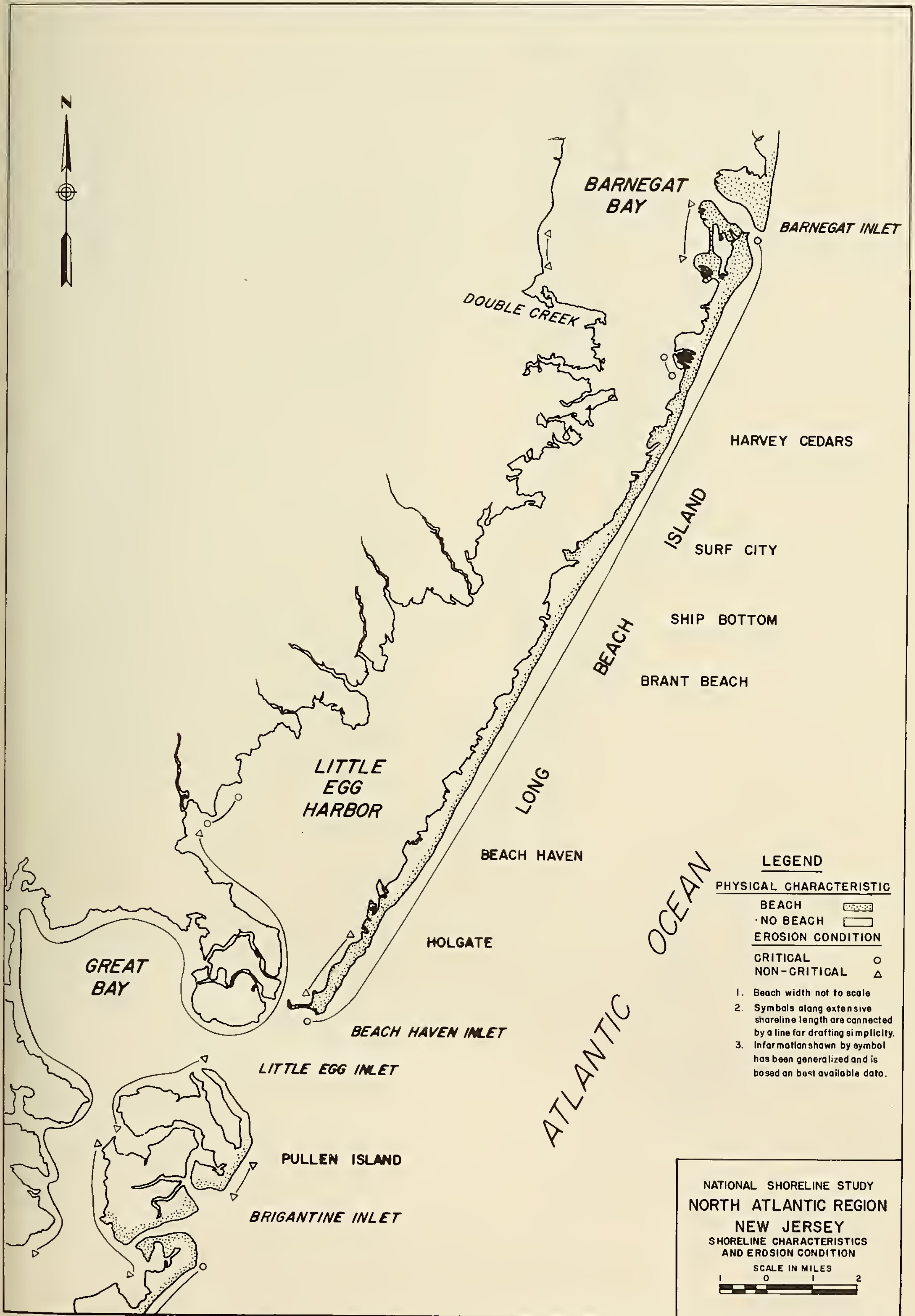

N
NEW JERSEY
ATLANTIC OCEAN
BRIGANTINE ISLAND
BRIGANTINE
ABSECON INLET
ATLANTIC CITY
ABSECON ISLAND
VENTNOR
MARGATE
LONGPORT
GREAT EGG HARBOR INLET
OCEAN CITY
PECK BEACH
LEGEND
OWNERSHIP
FEDERAL
NON-FEDERAL PUBLIC
PRIVATE
USE
PUBLIC RECREATIONAL
PRIVATE RECREATIONAL
NON-RECREATIONAL DEVELOPMENT
UNDEVELOPED
NOTE:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2

PLATE 38


N
BARNEGAT BAY
BARNEGAT INLET
DOUBLE CREEK
HARVEY CEDARS
ISLAND
SURF CITY
SHIP BOTTOM
BEACH
BRANT BEACH
LITTLE EGG HARBOR
LONG
BEACH HAVEN
HOLGATE
GREAT BAY
BEACH HAVEN INLET
LITTLE EGG INLET
ATLANTIC OCEAN
PULLEN ISLAND
BRIGANTINE INLET
LEGEND
PHYSICAL CHARACTERISTIC
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
1. Beach width not to scale
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbol has been generalized and is based on best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2

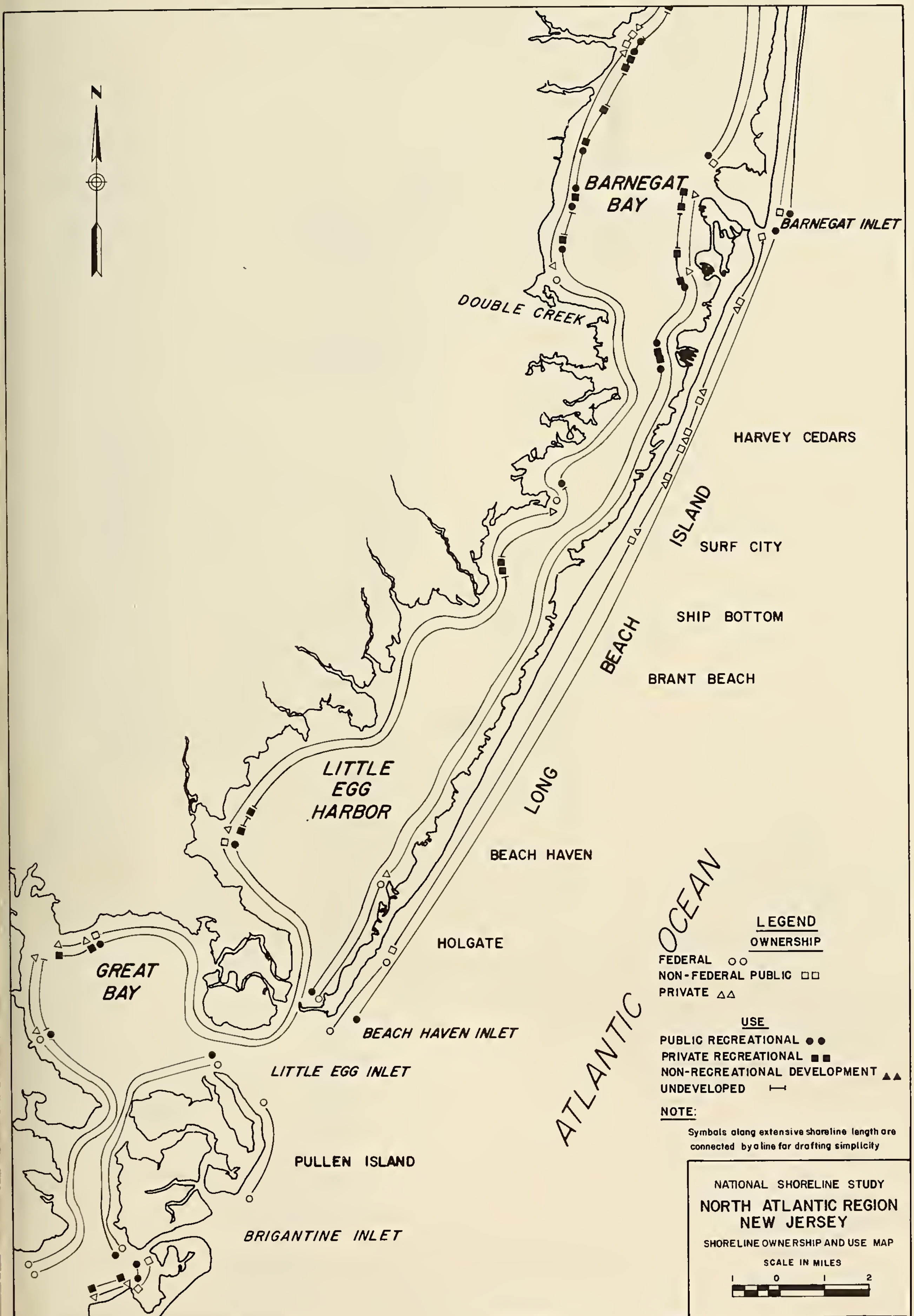

N
BARNEGAT BAY
BARNEGAT INLET
DOUBLE CREEK
HARVEY CEDARS
LONG BEACH ISLAND
SURF CITY
SHIP BOTTOM
BRANT BEACH
LITTLE EGG HARBOR
BEACH HAVEN
HOLGATE
ATLANTIC OCEAN
GREAT BAY
BEACH HAVEN INLET
LITTLE EGG INLET
PULLEN ISLAND
BRIGANTINE INLET
LEGEND
OWNERSHIP
FEDERAL ○○
NON-FEDERAL PUBLIC □□
PRIVATE △△
USE
PUBLIC RECREATIONAL ●●
PRIVATE RECREATIONAL ■■
NON-RECREATIONAL DEVELOPMENT ▲▲
UNDEVELOPED
NOTE:
Symbols along extensive shoreline length are connected by a line for drafting simplicity
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2

PLATE 40

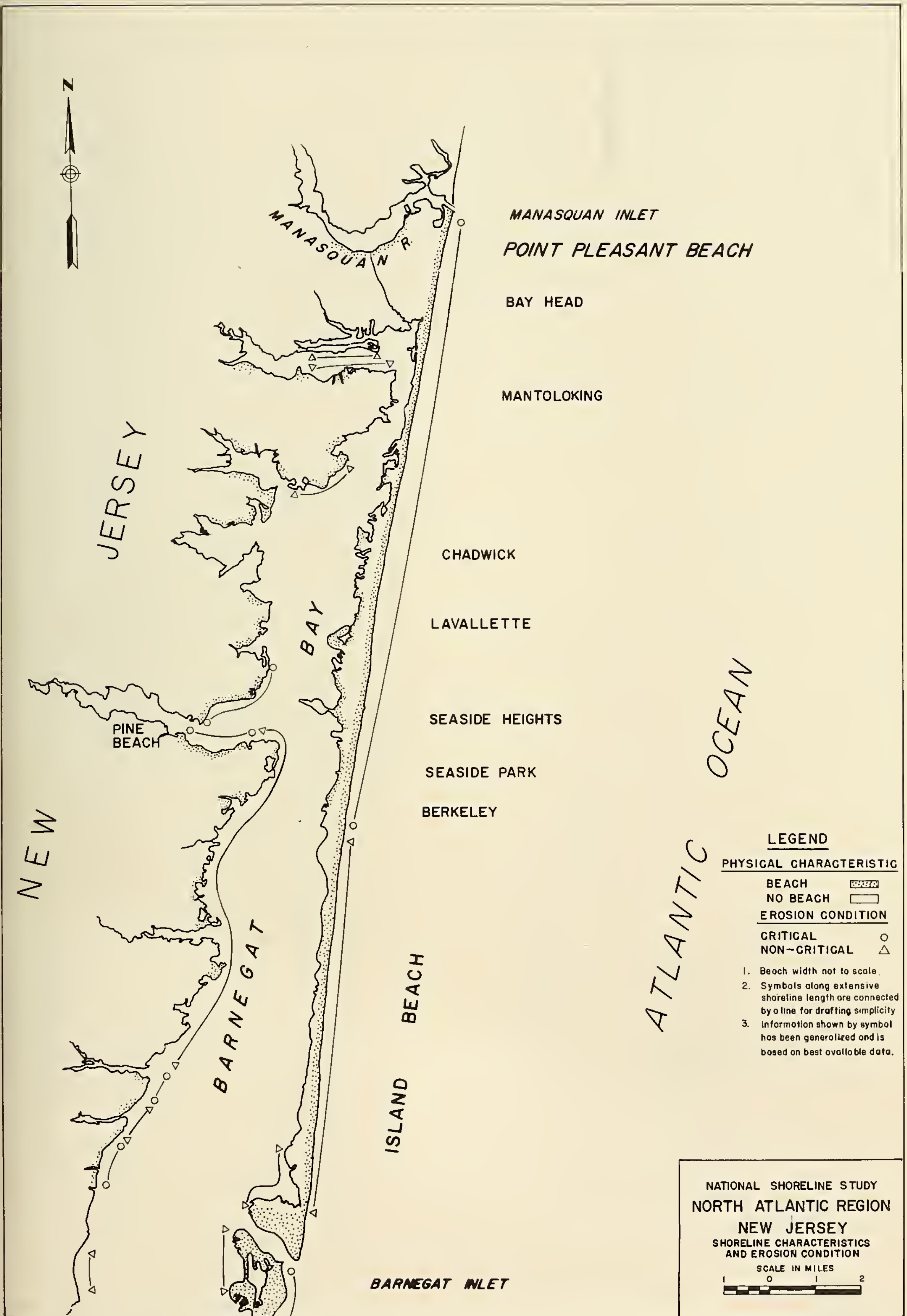
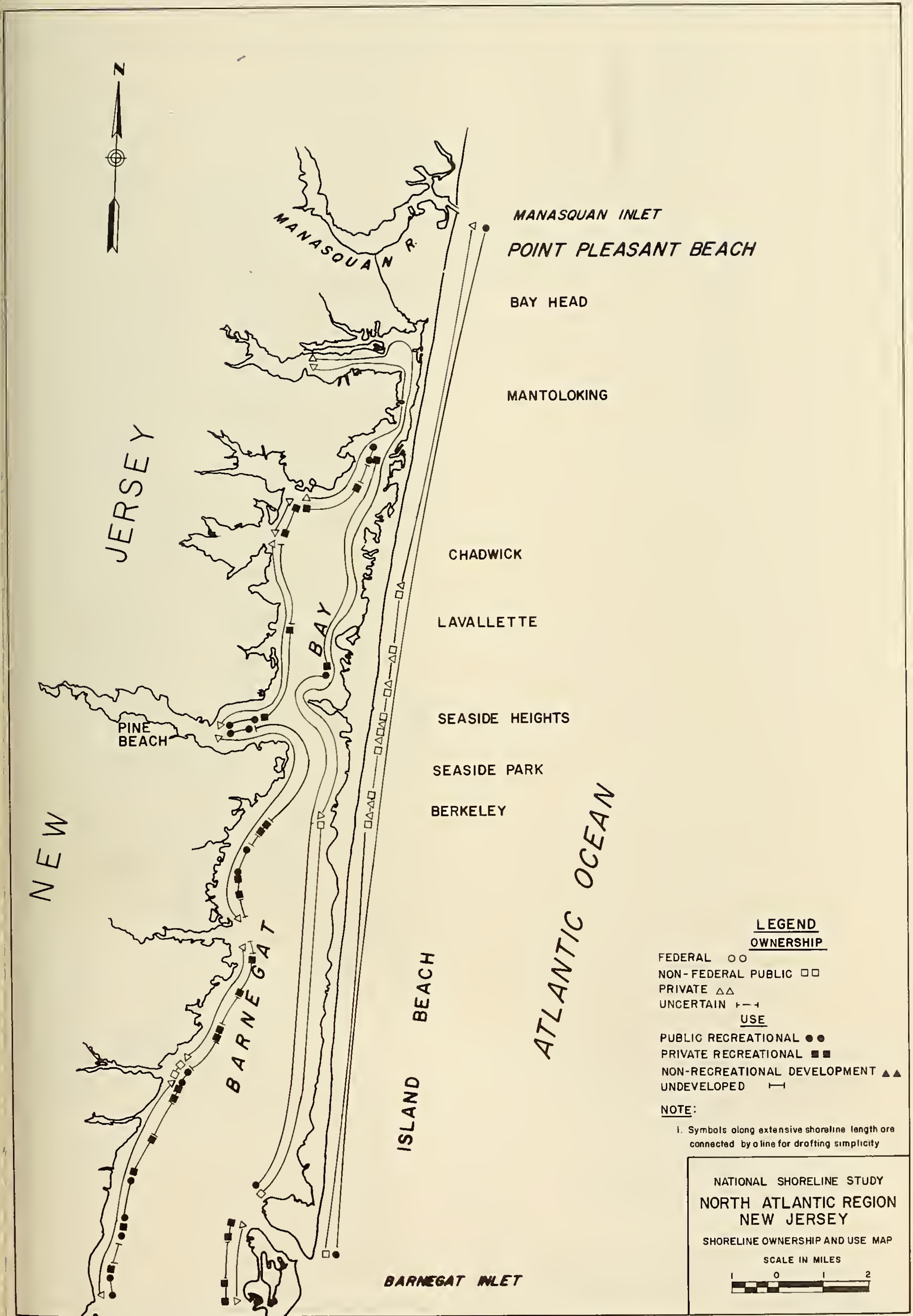

N
MANASQUAN INLET
POINT PLEASANT BEACH
MANASQUAN R.
BAY HEAD
MANTOLOKING
NEW JERSEY
CHADWICK
LAVALLETTE
BAY
SEASIDE HEIGHTS
PINE BEACH
SEASIDE PARK
BERKELEY
ATLANTIC OCEAN
BARNEGAT
ISLAND BEACH
BARNEGAT INLET
LEGEND
PHYSICAL CHARACTERISTIC
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity
3. Information shown by symbol has been generalized and is based on best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2

PLATE 41



N
MANASQUAN INLET
MANASQUAN R.
POINT PLEASANT BEACH
BAY HEAD
MANTOLOKING
JERSEY
CHADWICK
LAVALLETTE
BAY
PINE BEACH
SEASIDE HEIGHTS
SEASIDE PARK
BERKELEY
NEW
ATLANTIC OCEAN
BARNEGAT
BEACH
ISLAND
BARNEGAT INLET
LEGEND
OWNERSHIP
FEDERAL
NON-FEDERAL PUBLIC
PRIVATE
UNCERTAIN
USE
PUBLIC RECREATIONAL
PRIVATE RECREATIONAL
NON-RECREATIONAL DEVELOPMENT
UNDEVELOPED
NOTE:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2

PLATE 42

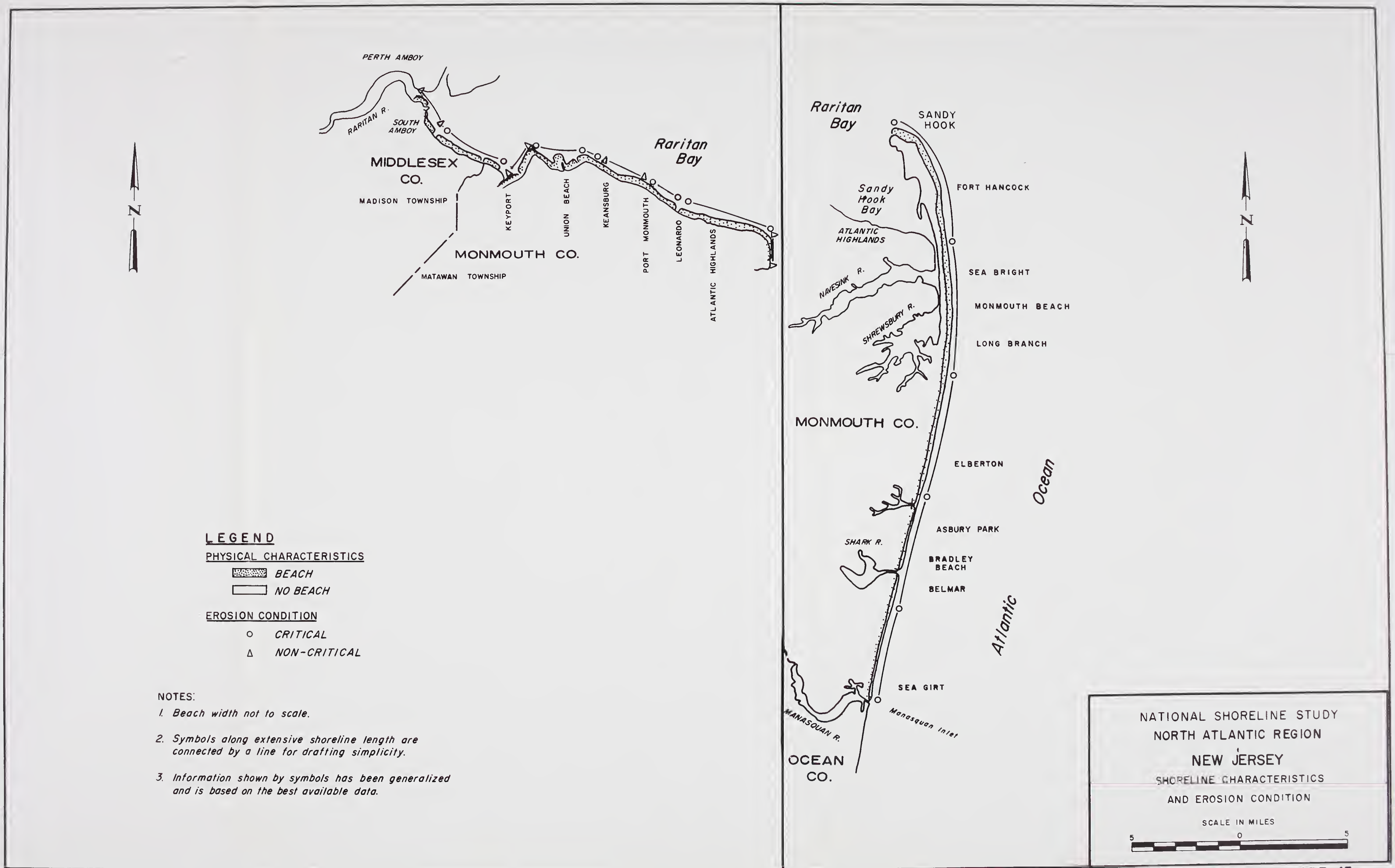
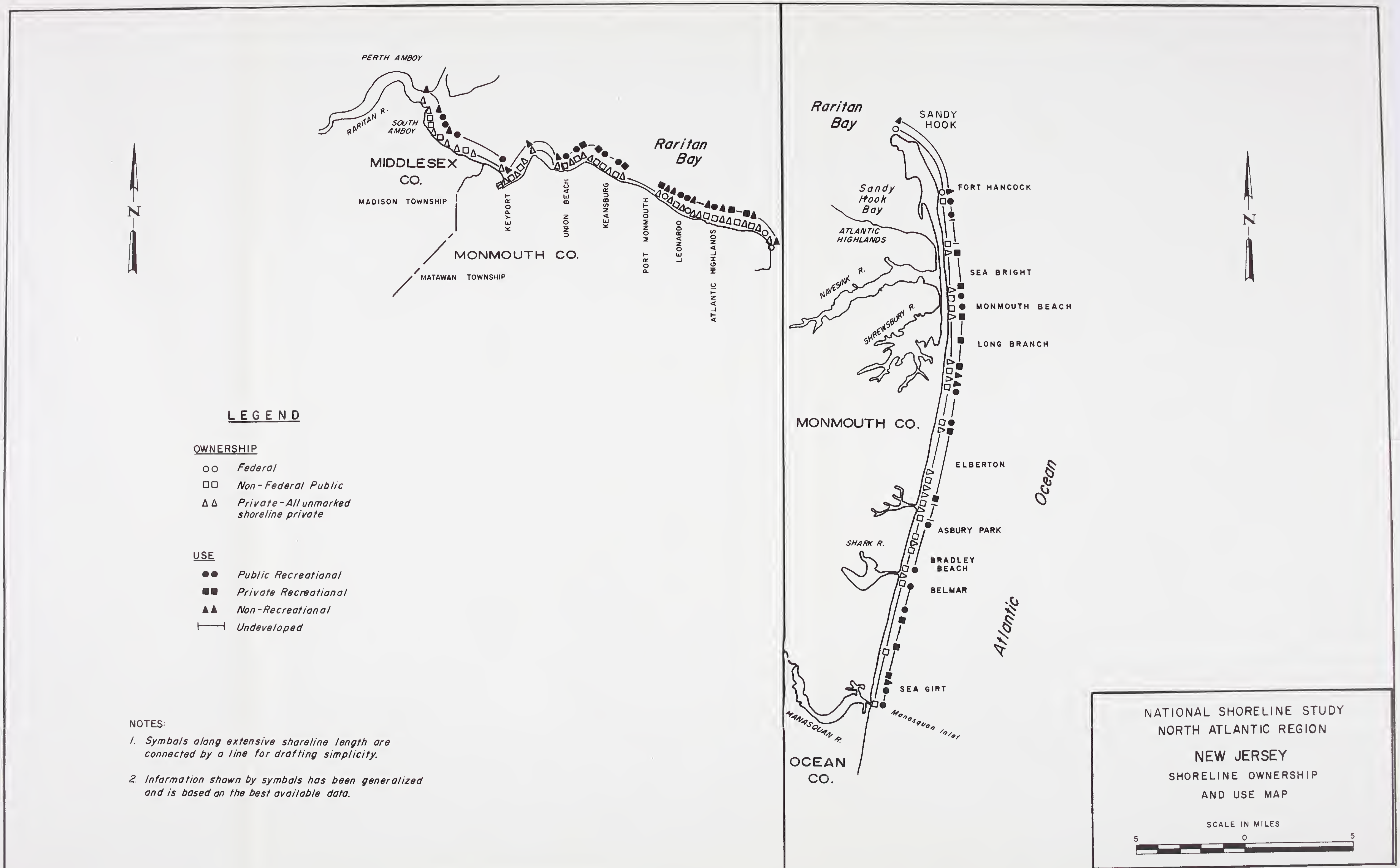

PERTH AMBOY
RARITAN R.
SOUTH AMBOY
MIDDLESEX CO.
MADISON TOWNSHIP
KEYPORT
UNION BEACH
KEANSBURG
PORT MONMOUTH
LEONARDO
ATLANTIC HIGHLANDS
Raritan Bay
MONMOUTH CO.
MATAWAN TOWNSHIP
N
LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
NOTES:
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
Raritan Bay
SANDY HOOK
Sandy Hook Bay
FORT HANCOCK
ATLANTIC HIGHLANDS
NAVESINK R.
SEA BRIGHT
SHREWSBURY R.
MONMOUTH BEACH
LONG BRANCH
MONMOUTH CO.
ELBERTON
Ocean
ASBURY PARK
SHARK R.
BRADLEY BEACH
BELMAR
Atlantic
SEA GIRT
Manasquan Inlet
MANASQUAN R.
OCEAN CO.
N
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE CHARACTERISTICS
AND EROSION CONDITION
SCALE IN MILES
5
0
5

PLATE 43


PERTH AMBOY
RARITAN R.
SOUTH AMBOY
MIDDLESEX CO.
MADISON TOWNSHIP
KEYPORT
UNION BEACH
KEANSBURG
PORT MONMOUTH
LEONARDO
ATLANTIC HIGHLANDS
Raritan Bay
MONMOUTH CO.
MATAWAN TOWNSHIP
N
Raritan Bay
SANDY HOOK
FORT HANCOCK
Sandy Hook Bay
ATLANTIC HIGHLANDS
NAVESINK R.
SHREWSBURY R.
SEA BRIGHT
MONMOUTH BEACH
LONG BRANCH
MONMOUTH CO.
ELBERTON
ASBURY PARK
SHARK R.
BRADLEY BEACH
BELMAR
SEA GIRT
MANASQUAN R.
Manasquan Inlet
OCEAN CO.
Atlantic Ocean
N
LEGEND
OWNERSHIP
Federal
Non-Federal Public
Private-All unmarked shoreline private.
USE
Public Recreational
Private Recreational
Non-Recreational
Undeveloped
NOTES:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
2. Information shown by symbols has been generalized and is based on the best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW JERSEY
SHORELINE OWNERSHIP
AND USE MAP
SCALE IN MILES
5
0
5

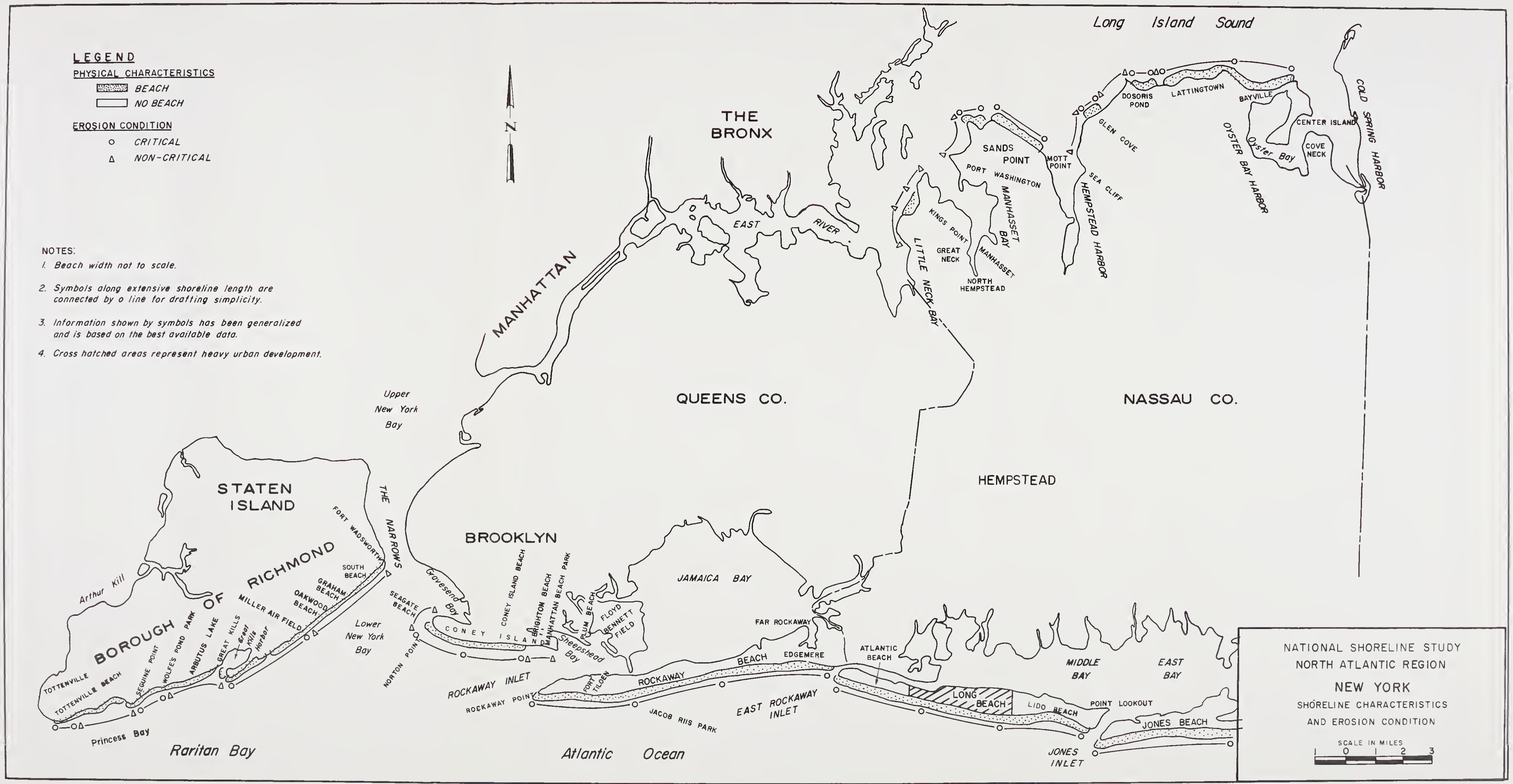
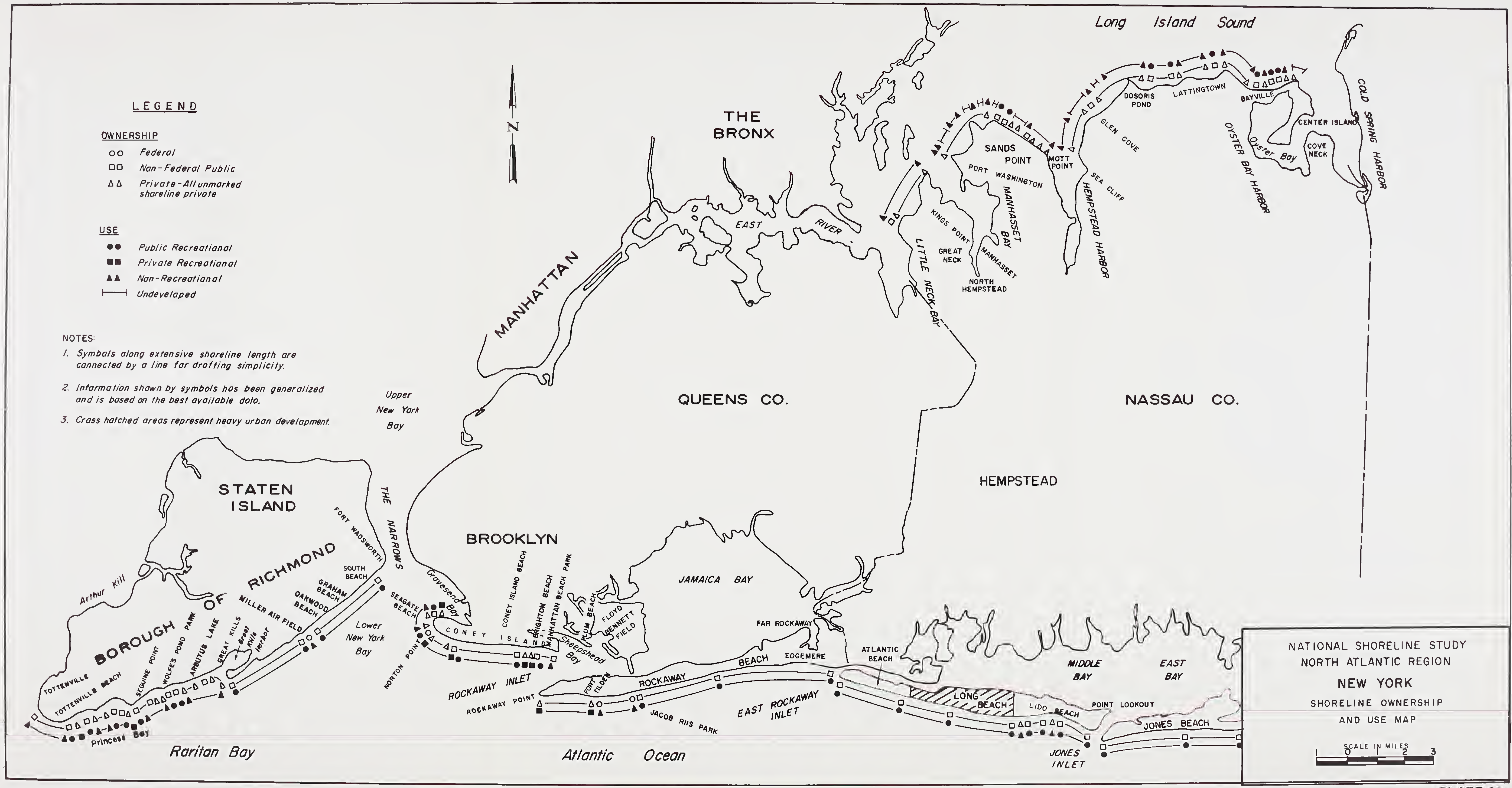

LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
NOTES:
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
4. Cross hatched areas represent heavy urban development.
N
Long Island Sound
THE BRONX
MANHATTAN
EAST RIVER
QUEENS CO.
NASSAU CO.
HEMPSTEAD
BROOKLYN
STATEN ISLAND
BOROUGH OF RICHMOND
Upper New York Bay
Lower New York Bay
THE NARROWS
Gravesend Bay
Sheepshead Bay
JAMAICA BAY
Raritan Bay
Princess Bay
Arthur Kill
Atlantic Ocean
ROCKAWAY INLET
EAST ROCKAWAY INLET
JONES INLET
MIDDLE BAY
EAST BAY
TOTTENVILLE
TOTTENVILLE BEACH
SEGUINE POINT
WOLFE'S POND PARK
ARBUTUS LAKE
GREAT KILLS
Great Kills Harbor
MILLER AIR FIELD
OAKWOOD BEACH
GRAHAM BEACH
SOUTH BEACH
FORT WADSWORTH
SEAGATE BEACH
NORTON POINT
CONEY ISLAND
CONEY ISLAND BEACH
BRIGHTON BEACH
MANHATTAN BEACH PARK
PLUM BEACH
FLOYD BENNETT FIELD
FAR ROCKAWAY
ROCKAWAY POINT
FORT TILDEN
ROCKAWAY BEACH
EDGEMERE
JACOB RIIS PARK
ATLANTIC BEACH
LONG BEACH
LIDO BEACH
POINT LOOKOUT
JONES BEACH
LITTLE NECK BAY
KINGS POINT
GREAT NECK
MANHASSET
NORTH HEMPSTEAD
MANHASSET BAY
PORT WASHINGTON
SANDS POINT
MOTT POINT
HEMPSTEAD HARBOR
GLEN COVE
SEA CLIFF
DOSORIS POND
LATTINGTOWN
BAYVILLE
OYSTER BAY HARBOR
Oyster Bay
CENTER ISLAND
COVE NECK
COLD SPRING HARBOR
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW YORK
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2 3

PLATE 45



LEGEND
OWNERSHIP
Federal
Nan-Federal Public
Private-All unmarked shoreline privote
USE
Public Recreatianal
Private Recreatianal
Nan-Recreatianal
Undevelaped
NOTES:
1. Symbals along extensive shareline length are cannected by a line far drofting simplicity.
2. Infarmation shawn by symbals has been generalized and is based on the best available doto.
3. Crass hatched areas represent heavy urban develapment.
Long Island Sound
THE BRONX
MANHATTAN
EAST RIVER
QUEENS CO.
NASSAU CO.
HEMPSTEAD
STATEN ISLAND
BOROUGH OF RICHMOND
BROOKLYN
JAMAICA BAY
Upper New York Bay
Lower New York Bay
THE NARROWS
Arthur Kill
Raritan Bay
Atlantic Ocean
Princess Bay
TOTTENVILLE
TOTTENVILLE BEACH
SEGUINE POINT
WOLFE'S POND PARK
ARBUTUS LAKE
GREAT KILLS
Great Kills Harbor
MILLER AIR FIELD
OAKWOOD BEACH
GRAHAM BEACH
SOUTH BEACH
FORT WADSWORTH
SEAGATE BEACH
Gravesend Bay
NORTON POINT
CONEY ISLAND
CONEY ISLAND BEACH
BRIGHTON BEACH
MANHATTAN BEACH PARK
Sheepshead Bay
PLUM BEACH
FLOYD BENNETT FIELD
ROCKAWAY INLET
ROCKAWAY POINT
FORT TILDEN
JACOB RIIS PARK
ROCKAWAY BEACH
EDGEMERE
FAR ROCKAWAY
EAST ROCKAWAY INLET
ATLANTIC BEACH
LONG BEACH
LIDO BEACH
POINT LOOKOUT
MIDDLE BAY
EAST BAY
JONES INLET
JONES BEACH
LITTLE NECK BAY
KINGS POINT
GREAT NECK
MANHASSET
NORTH HEMPSTEAD
MANHASSET BAY
PORT WASHINGTON
SANDS POINT
MOTT POINT
HEMPSTEAD HARBOR
SEA CLIFF
GLEN COVE
DOSORIS POND
LATTINGTOWN
BAYVILLE
OYSTER BAY HARBOR
Oyster Bay
CENTER ISLAND
COVE NECK
COLD SPRING HARBOR
N
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW YORK
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2 3

PLATE 46

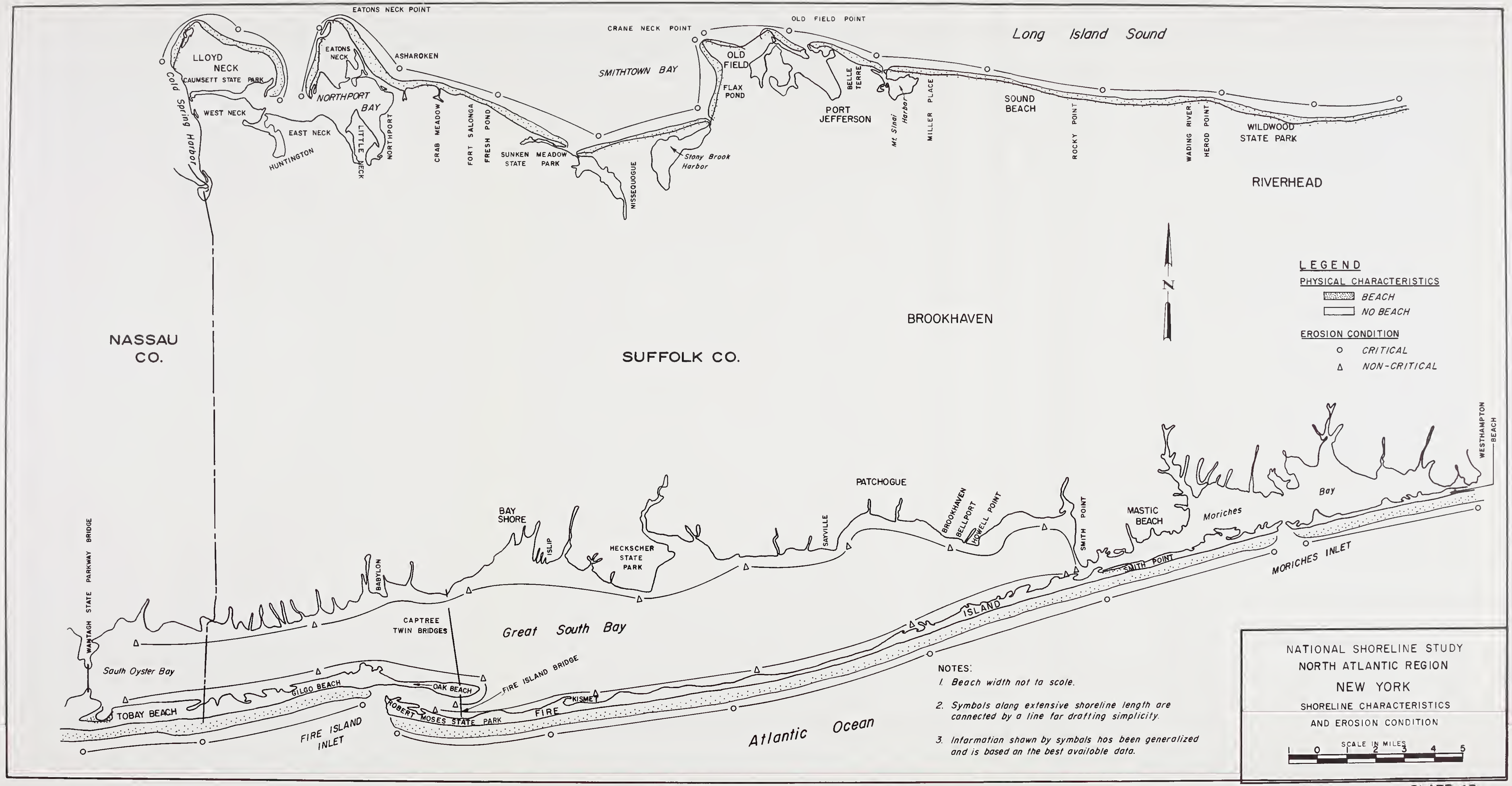

Long Island Sound
EATONS NECK POINT
CRANE NECK POINT
OLD FIELD POINT
LLOYD NECK
CAUMSETT STATE PARK
Cold Spring Harbor
EATONS NECK
ASHAROKEN
NORTHPORT BAY
WEST NECK
EAST NECK
HUNTINGTON
LITTLE NECK
NORTHPORT
CRAB MEADOW
FORT SALONGA
FRESH POND
SUNKEN MEADOW STATE PARK
SMITHTOWN BAY
NISSEQUOGUE
Stony Brook Harbor
OLD FIELD
FLAX POND
PORT JEFFERSON
BELLE TERRE
Mt. Sinai Harbor
MILLER PLACE
SOUND BEACH
ROCKY POINT
WADING RIVER
HEROD POINT
WILDWOOD STATE PARK
RIVERHEAD
N
LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
NASSAU CO.
SUFFOLK CO.
BROOKHAVEN
WANTAGH STATE PARKWAY BRIDGE
South Oyster Bay
TOBAY BEACH
GILGO BEACH
FIRE ISLAND INLET
BABYLON
BAY SHORE
ISLIP
HECKSCHER STATE PARK
CAPTREE TWIN BRIDGES
Great South Bay
OAK BEACH
FIRE ISLAND BRIDGE
ROBERT MOSES STATE PARK
KISMET
FIRE ISLAND
Atlantic Ocean
SAYVILLE
PATCHOGUE
BROOKHAVEN
BELLPORT
HOWELL POINT
SMITH POINT
MASTIC BEACH
SMITH POINT
Moriches Bay
MORICHES INLET
WESTHAMPTON BEACH
NOTES:
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW YORK
SHORELINE CHARACTERISTICS
AND EROSION CONDITION
SCALE IN MILES
1 0 1 2 3 4 5

PLATE 47

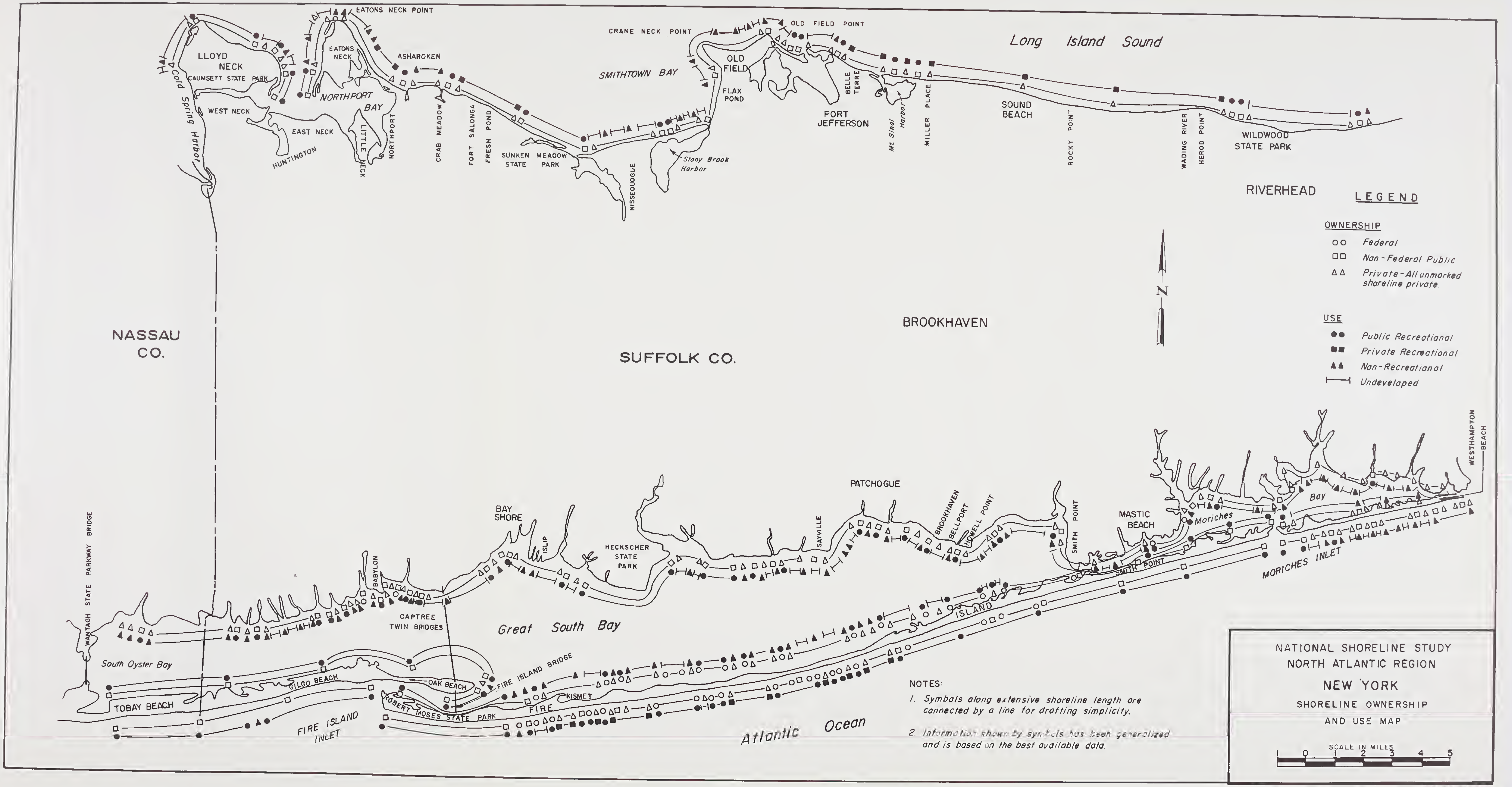
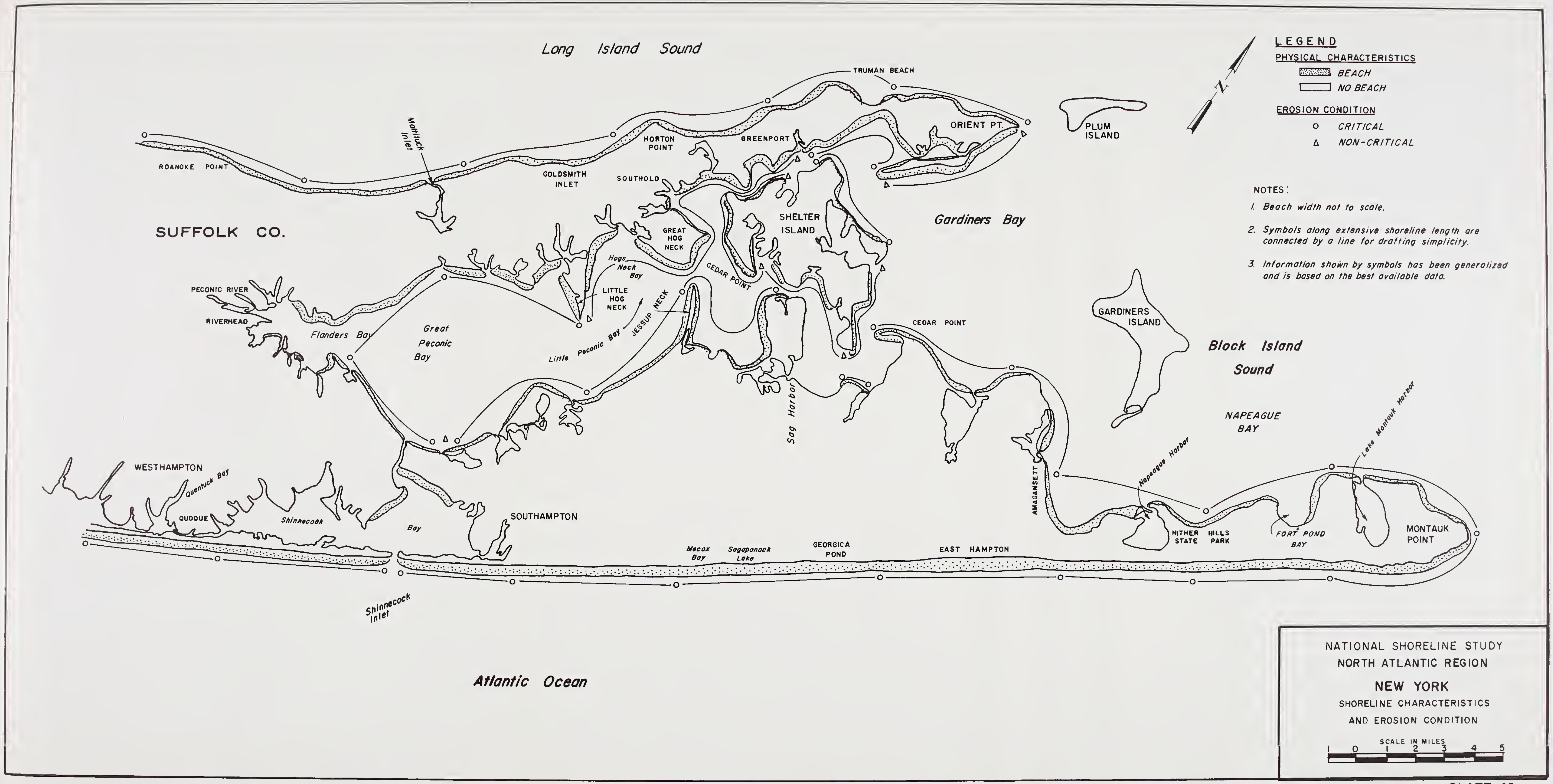

Long Island Sound
LLOYD NECK
CAUMSETT STATE PARK
Cold Spring Harbor
WEST NECK
EAST NECK
HUNTINGTON
EATONS NECK POINT
EATONS NECK
NORTHPORT BAY
LITTLE NECK
NORTHPORT
ASHAROKEN
CRAB MEADOW
FORT SALONGA
FRESH POND
SUNKEN MEADOW STATE PARK
NISSEQUOGUE
SMITHTOWN BAY
CRANE NECK POINT
Stony Brook Harbor
OLD FIELD
OLD FIELD POINT
FLAX POND
PORT JEFFERSON
BELLE TERRE
Mt. Sinai Harbor
MILLER PLACE
SOUND BEACH
ROCKY POINT
WADING RIVER
HEROD POINT
WILDWOOD STATE PARK
RIVERHEAD
NASSAU CO.
SUFFOLK CO.
BROOKHAVEN
N
LEGEND
OWNERSHIP
Federal
Non-Federal Public
Private-All unmarked shoreline private.
USE
Public Recreational
Private Recreational
Non-Recreational
Undeveloped
WANTAGH STATE PARKWAY BRIDGE
South Oyster Bay
TOBAY BEACH
GILGO BEACH
FIRE ISLAND INLET
BABYLON
CAPTREE TWIN BRIDGES
OAK BEACH
ROBERT MOSES STATE PARK
FIRE ISLAND BRIDGE
KISMET
BAY SHORE
ISLIP
HECKSCHER STATE PARK
Great South Bay
SAYVILLE
PATCHOGUE
BROOKHAVEN
BELLPORT
HOWELL POINT
FIRE ISLAND
SMITH POINT
MASTIC BEACH
Moriches Bay
MORICHES INLET
WESTHAMPTON BEACH
Atlantic Ocean
NOTES:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
2. Information shown by symbols has been generalized and is based on the best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW YORK
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2 3 4 5

PLATE 48



Long Island Sound
LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
NOTES:
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
TRUMAN BEACH
ORIENT PT.
PLUM ISLAND
GREENPORT
HORTON POINT
SOUTHOLD
GOLDSMITH INLET
Mattituck Inlet
ROANOKE POINT
SUFFOLK CO.
GREAT HOG NECK
SHELTER ISLAND
Gardiners Bay
Hogs Neck Bay
LITTLE HOG NECK
CEDAR POINT
JESSUP NECK
PECONIC RIVER
RIVERHEAD
Flanders Bay
Great Peconic Bay
Little Peconic Bay
CEDAR POINT
GARDINERS ISLAND
Block Island Sound
NAPEAGUE BAY
Lake Montauk Harbor
Napeague Harbor
Sag Harbor
AMAGANSETT
HITHER HILLS STATE PARK
FORT POND BAY
MONTAUK POINT
WESTHAMPTON
Quantuck Bay
QUOQUE
Shinnecock
Bay
SOUTHAMPTON
Mecox Bay
Sagaponack Lake
GEORGICA POND
EAST HAMPTON
Shinnecock Inlet
Atlantic Ocean
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW YORK
SHORELINE CHARACTERISTICS
AND EROSION CONDITION
SCALE IN MILES
1 0 1 2 3 4 5

PLATE 49

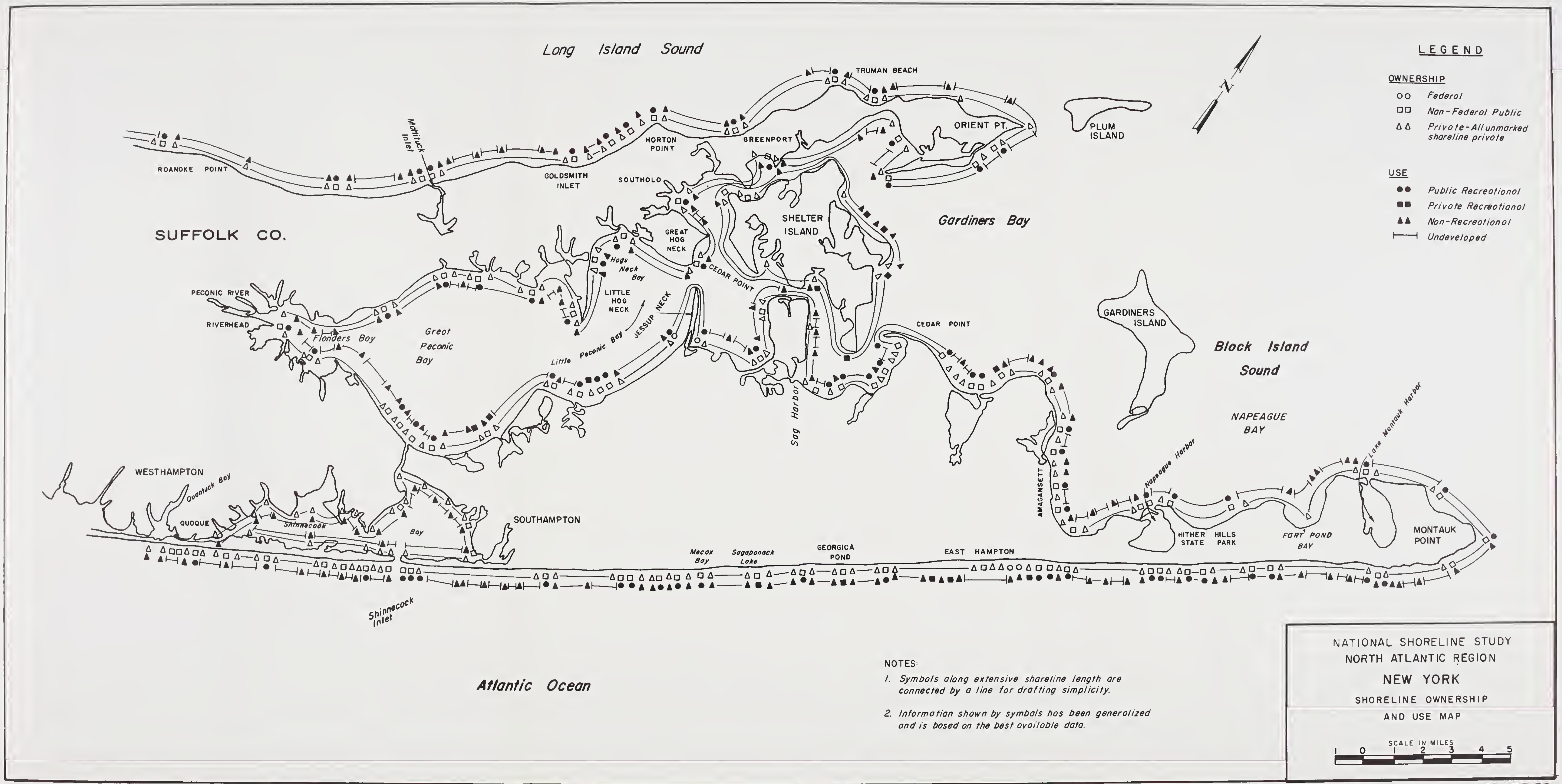

Long Island Sound
TRUMAN BEACH
ORIENT PT.
PLUM ISLAND
N
LEGEND
OWNERSHIP
Federal
Non-Federal Public
Private-All unmarked shoreline private
USE
Public Recreational
Private Recreational
Non-Recreational
Undeveloped
Mattituck Inlet
ROANOKE POINT
GOLDSMITH INLET
HORTON POINT
GREENPORT
SOUTHOLD
SUFFOLK CO.
SHELTER ISLAND
Gardiners Bay
GREAT HOG NECK
Hogs Neck Bay
LITTLE HOG NECK
CEDAR POINT
PECONIC RIVER
RIVERHEAD
Flanders Bay
Great Peconic Bay
Little Peconic Bay
JESSUP NECK
CEDAR POINT
GARDINERS ISLAND
Block Island Sound
Sag Harbor
NAPEAGUE BAY
Lake Montauk Harbor
Napeague Harbor
AMAGANSETT
WESTHAMPTON
Quantuck Bay
QUOQUE
Shinnecock
Bay
SOUTHAMPTON
Mecox Bay
Sagaponack Lake
GEORGICA POND
EAST HAMPTON
HITHER HILLS STATE PARK
FORT POND BAY
MONTAUK POINT
Shinnecock Inlet
Atlantic Ocean
NOTES:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
2. Information shown by symbols has been generalized and is based on the best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW YORK
SHORELINE OWNERSHIP
AND USE MAP
SCALE IN MILES
1 0 1 2 3 4 5

PLATE 50

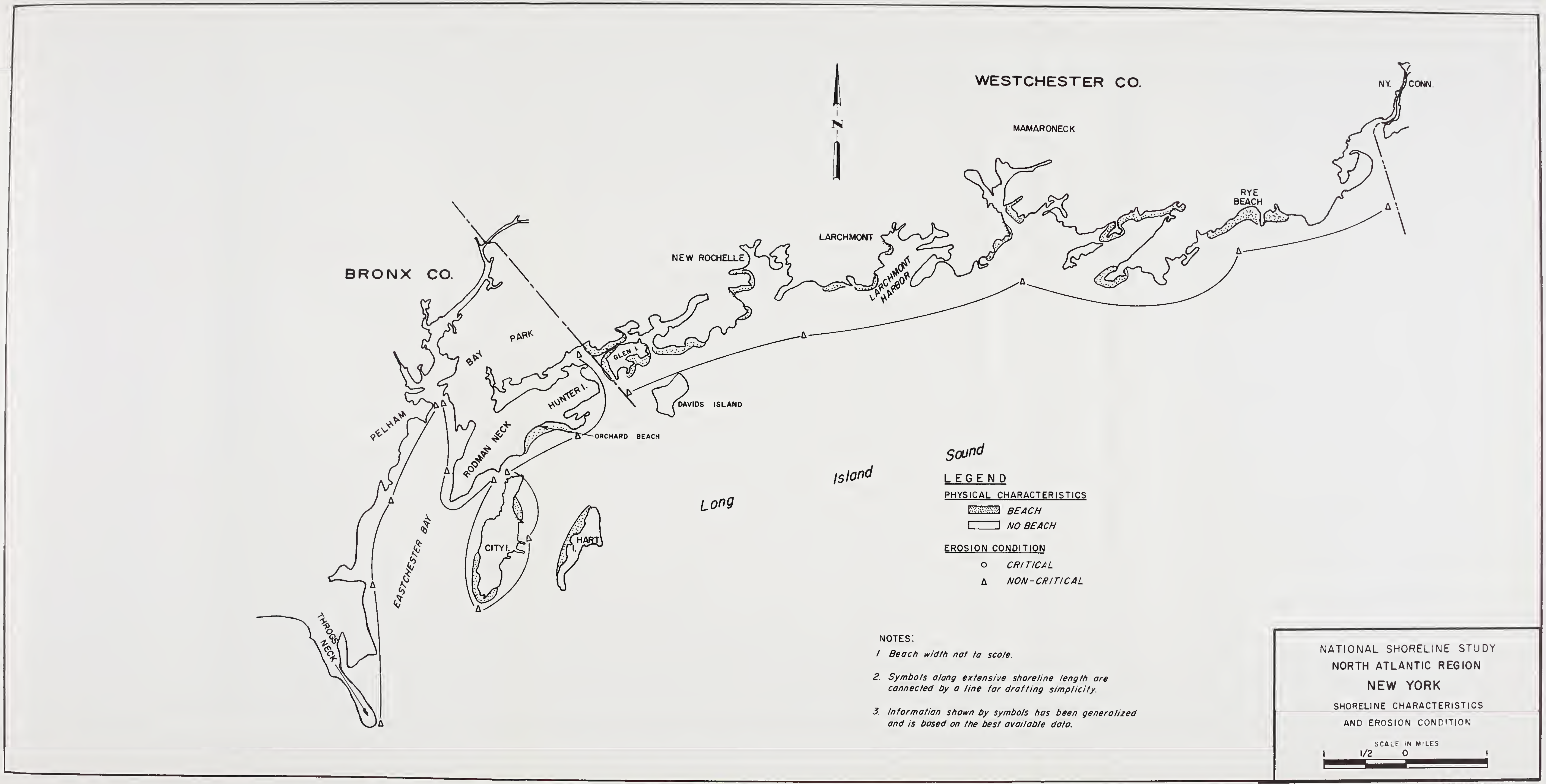

WESTCHESTER CO.
NY.
CONN.
N
MAMARONECK
RYE BEACH
LARCHMONT
NEW ROCHELLE
LARCHMONT HARBOR
BRONX CO.
BAY
PARK
GLEN I.
HUNTER I.
DAVIDS ISLAND
PELHAM
RODMAN NECK
ORCHARD BEACH
Sound
Island
Long
EASTCHESTER BAY
CITY I.
HART I.
THROGS NECK
LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
NOTES:
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW YORK
SHORELINE CHARACTERISTICS
AND EROSION CONDITION
SCALE IN MILES
1
1/2
0
1

PLATE 51

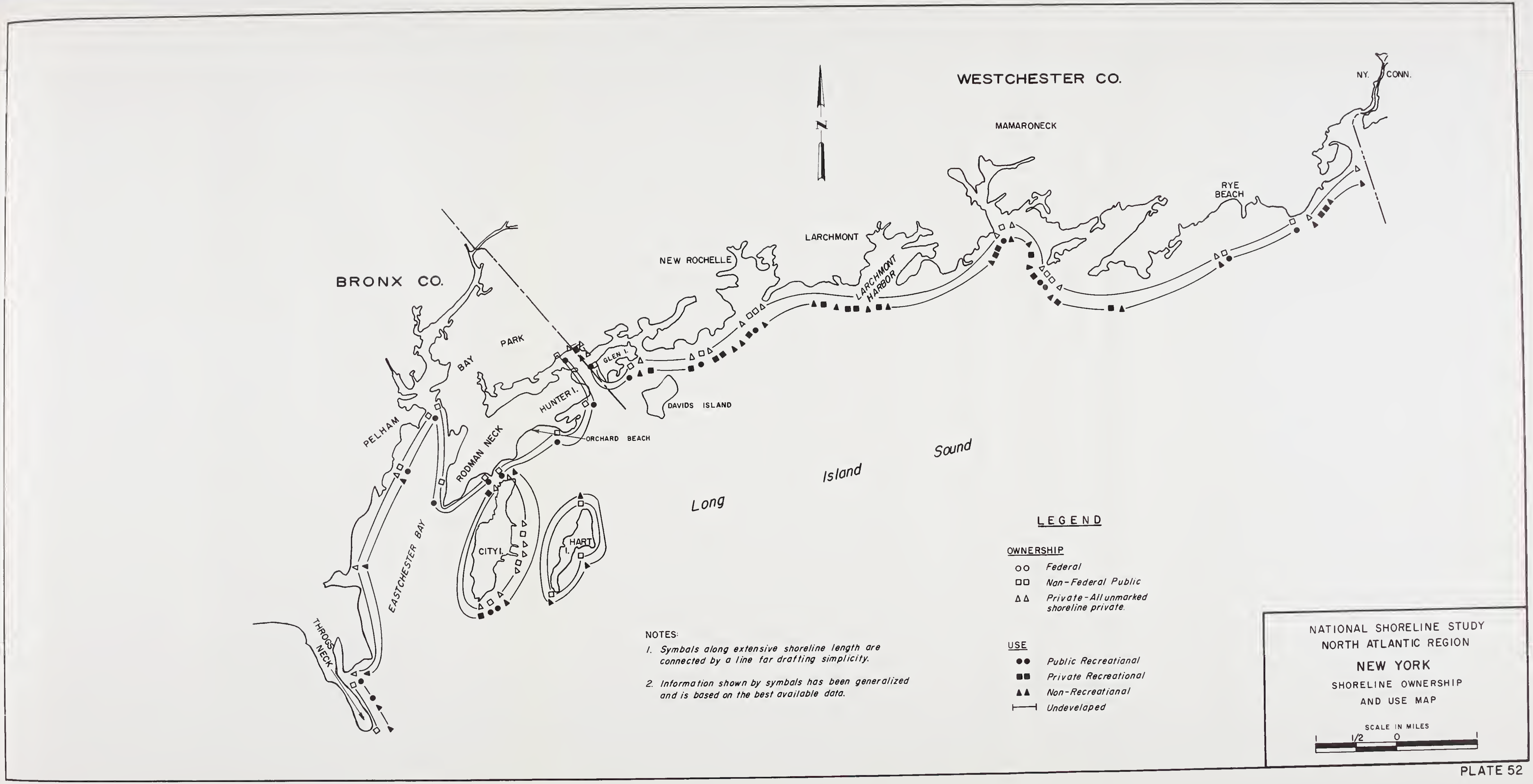
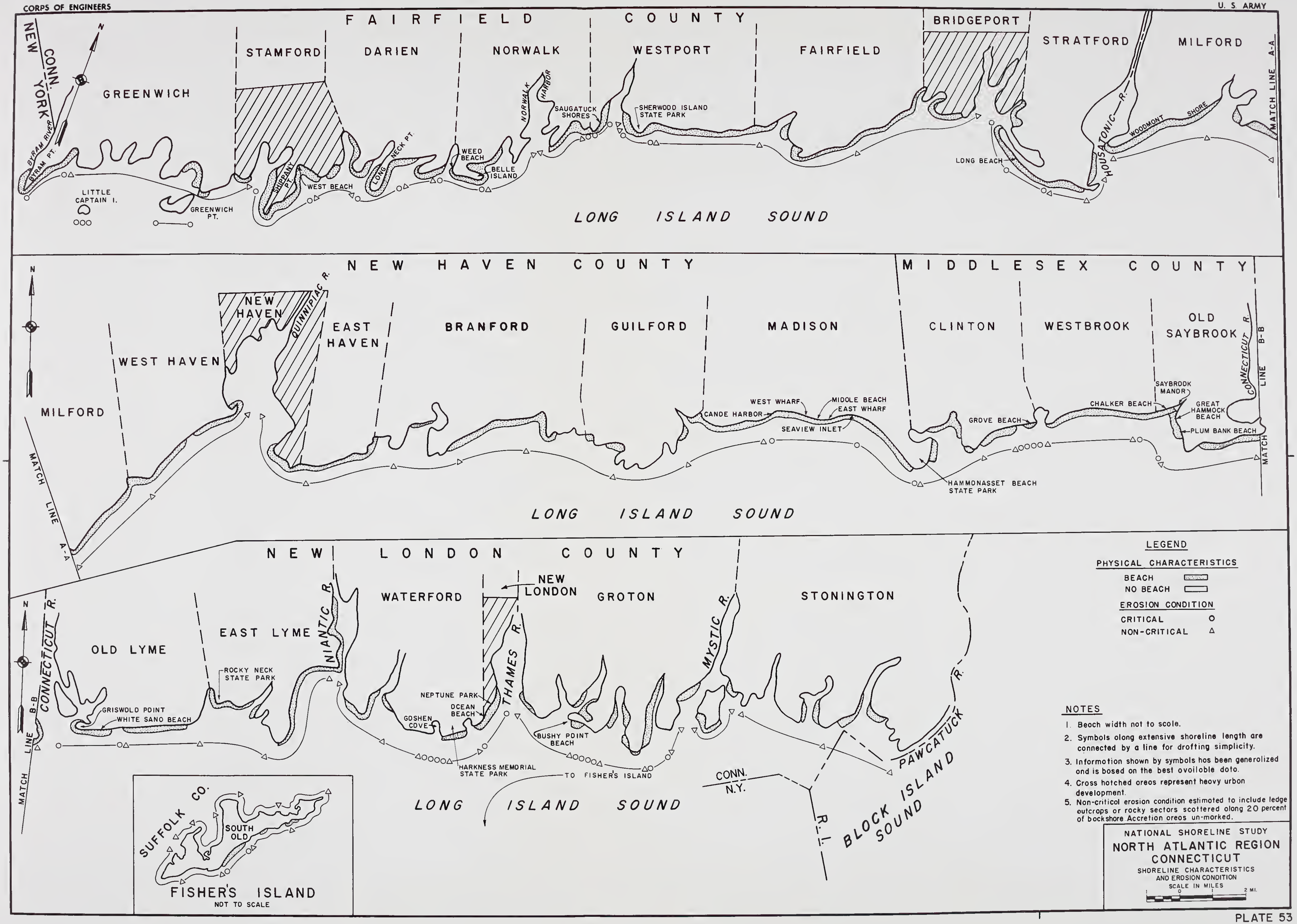
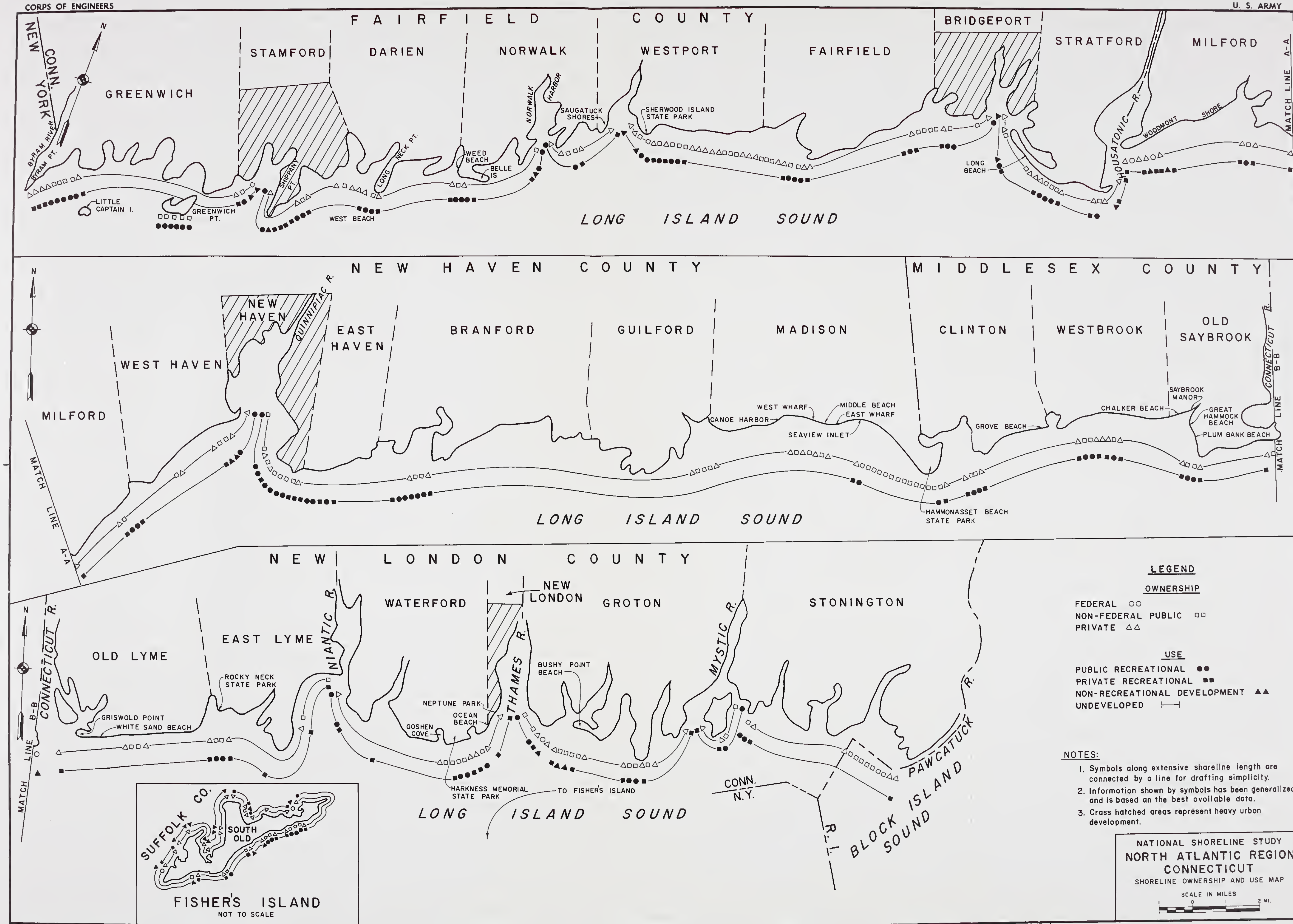
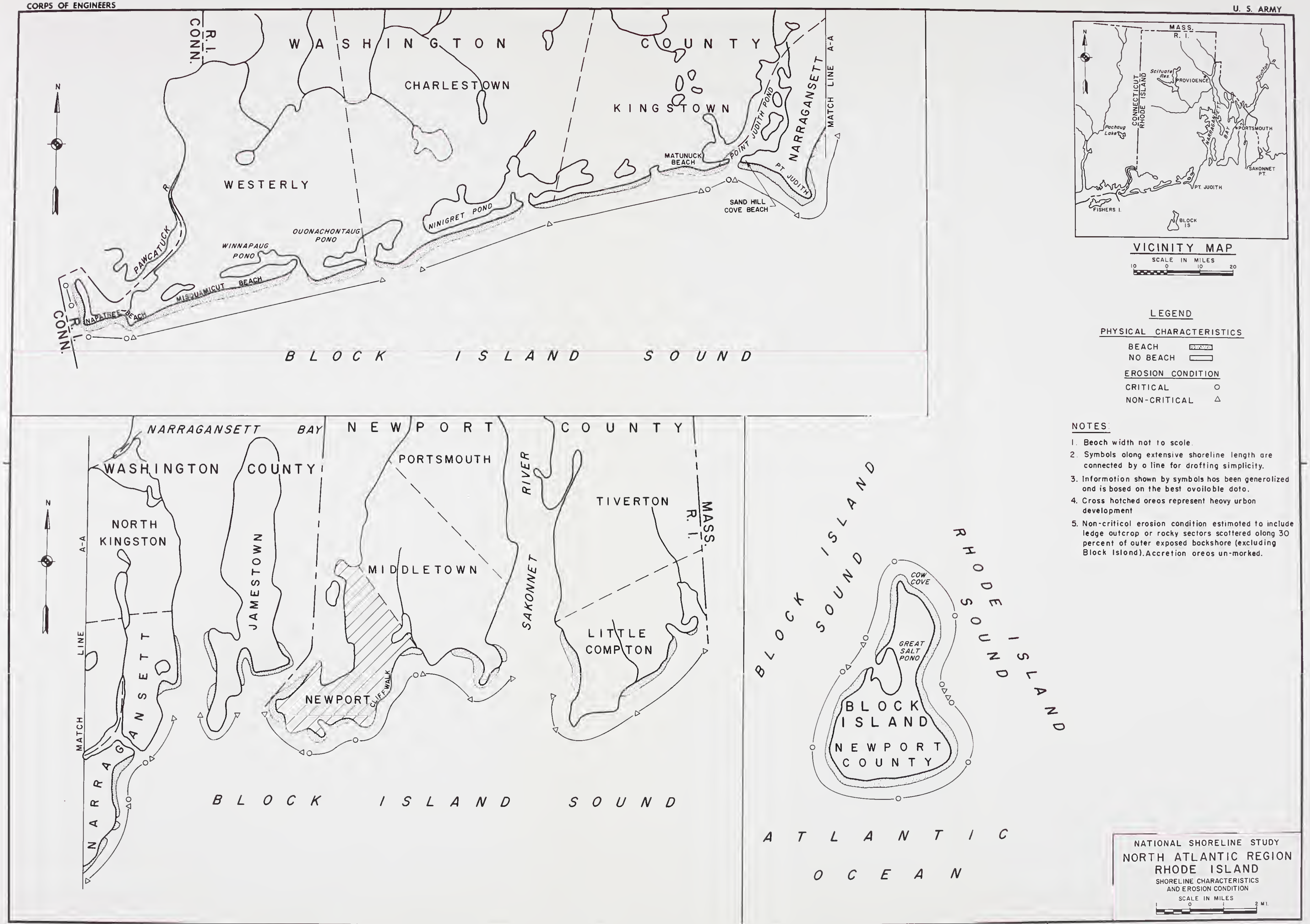
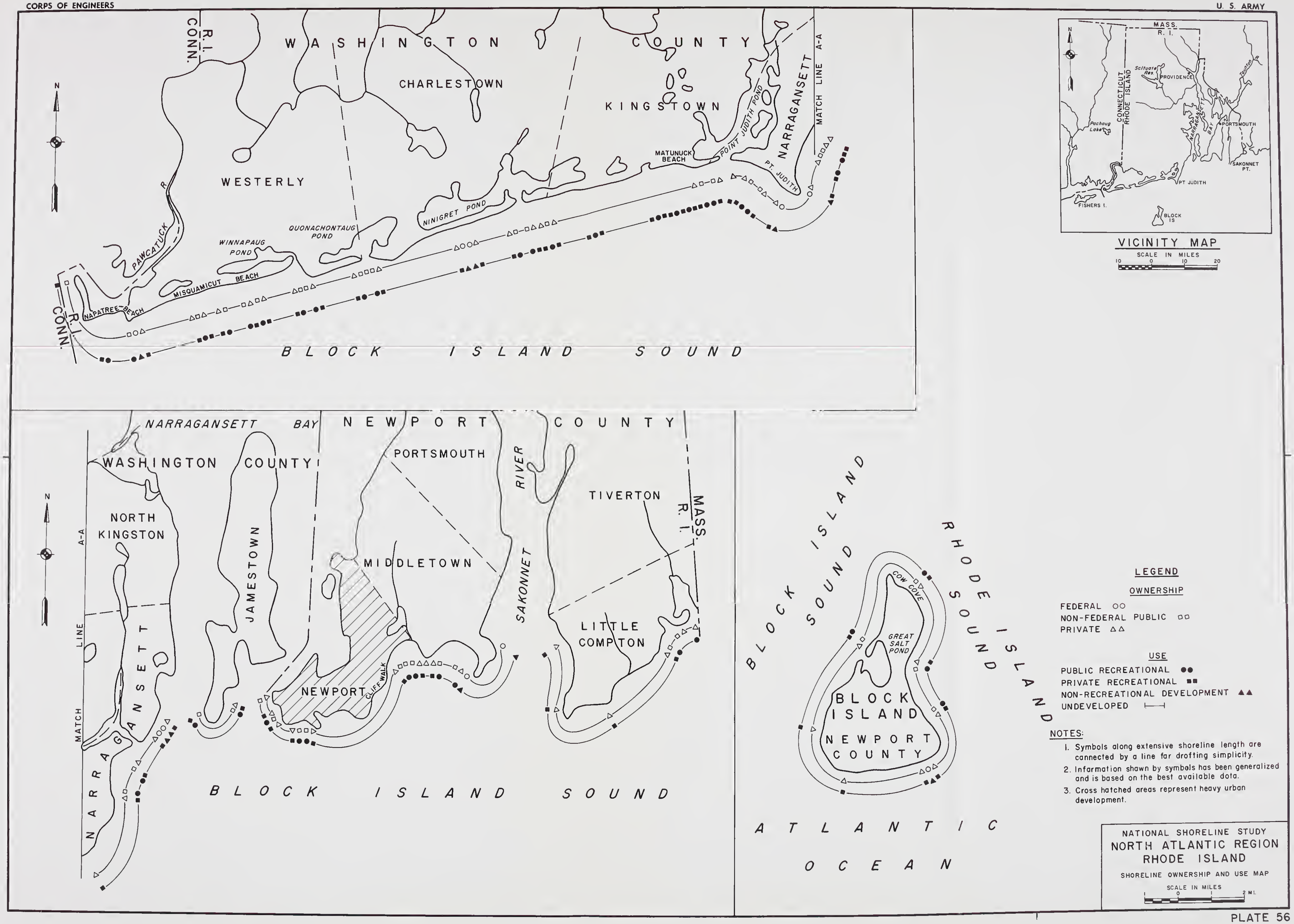

WESTCHESTER CO.
NY.
CONN.
N
MAMARONECK
RYE BEACH
LARCHMONT
NEW ROCHELLE
LARCHMONT HARBOR
BRONX CO.
PARK
BAY
GLEN I.
HUNTER I.
DAVIDS ISLAND
PELHAM
RODMAN NECK
ORCHARD BEACH
Long Island Sound
EASTCHESTER BAY
CITY I.
HART I.
THROGS NECK
NOTES:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
2. Information shown by symbols has been generalized and is based on the best available data.
LEGEND
OWNERSHIP
Federal
Non-Federal Public
Private - All unmarked shoreline private.
USE
Public Recreational
Private Recreational
Non-Recreational
Undeveloped
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW YORK
SHORELINE OWNERSHIP
AND USE MAP
SCALE IN MILES
1/2
0
1

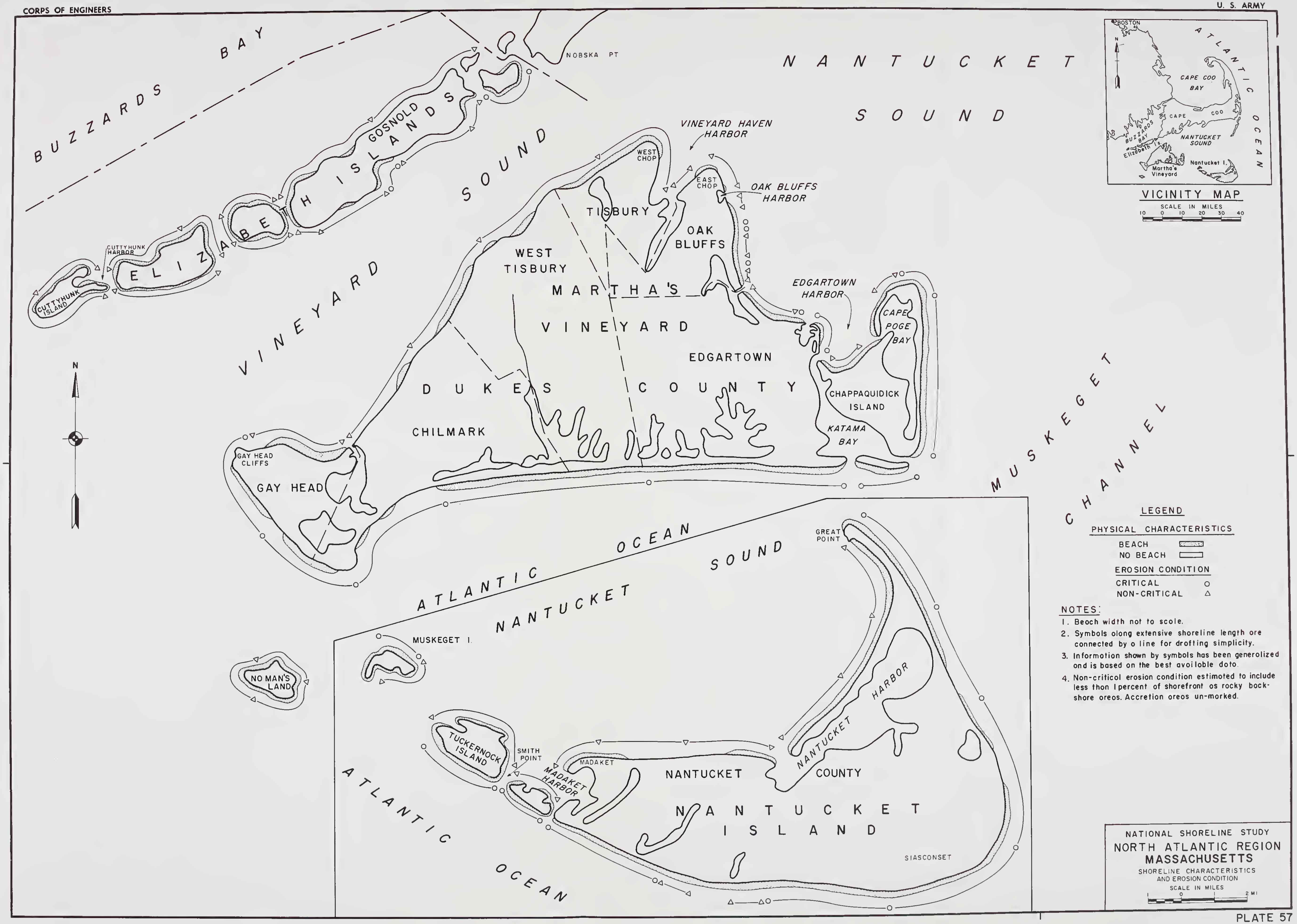
PLATE 52

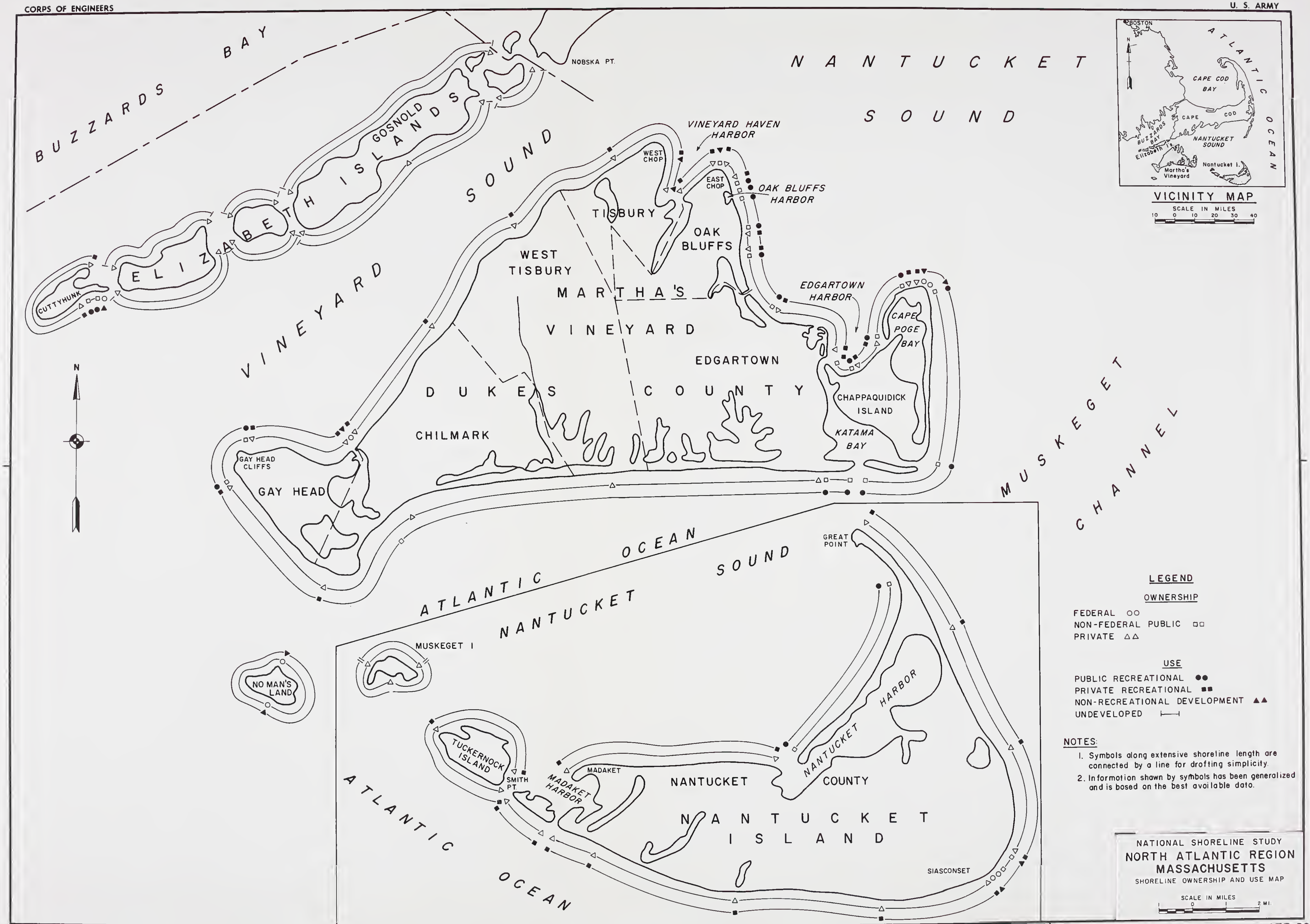

FAIRFIELD COUNTY
NEW YORK
CONN.
GREENWICH
STAMFORD
DARIEN
NORWALK
WESTPORT
FAIRFIELD
BRIDGEPORT
STRATFORD
MILFORD
MATCH LINE A-A
BYRAM RIVER
BYRAM PT.
LITTLE CAPTAIN I.
GREENWICH PT.
SHIPPANY PT.
WEST BEACH
LONG NECK PT.
WEED BEACH
BELLE ISLAND
NORWALK HARBOR
SAUGATUCK SHORES
SHERWOOD ISLAND STATE PARK
LONG BEACH
HOUSATONIC R.
WOODMONT SHORE
LONG ISLAND SOUND
NEW HAVEN COUNTY
MIDDLESEX COUNTY
MILFORD
WEST HAVEN
NEW HAVEN
QUINNIPIAC R.
EAST HAVEN
BRANFORD
GUILFORD
MADISON
CLINTON
WESTBROOK
OLD SAYBROOK
CONNECTICUT R.
MATCH LINE A-A
WEST WHARF
MIDDLE BEACH
EAST WHARF
CANOE HARBOR
SEAVIEW INLET
HAMMONASSET BEACH STATE PARK
GROVE BEACH
CHALKER BEACH
SAYBROOK MANOR
GREAT HAMMOCK BEACH
PLUM BANK BEACH
MATCH LINE B-B
LONG ISLAND SOUND
NEW LONDON COUNTY
OLD LYME
EAST LYME
NIANTIC R.
WATERFORD
NEW LONDON
GROTON
STONINGTON
CONNECTICUT R.
MATCH LINE B-B
ROCKY NECK STATE PARK
GRISWOLD POINT
WHITE SAND BEACH
NEPTUNE PARK
OCEAN BEACH
GOSHEN COVE
THAMES R.
HARKNESS MEMORIAL STATE PARK
BUSHY POINT BEACH
MYSTIC R.
TO FISHER'S ISLAND
CONN.
N.Y.
R.I.
PAWCATUCK R.
BLOCK ISLAND SOUND
LONG ISLAND SOUND
SUFFOLK CO.
SOUTH OLD
FISHER'S ISLAND
NOT TO SCALE
LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
NOTES
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
4. Cross hatched areas represent heavy urban development.
5. Non-critical erosion condition estimated to include ledge outcrops or rocky sectors scattered along 20 percent of backshore Accretion areas un-marked.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
CONNECTICUT
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2 MI.

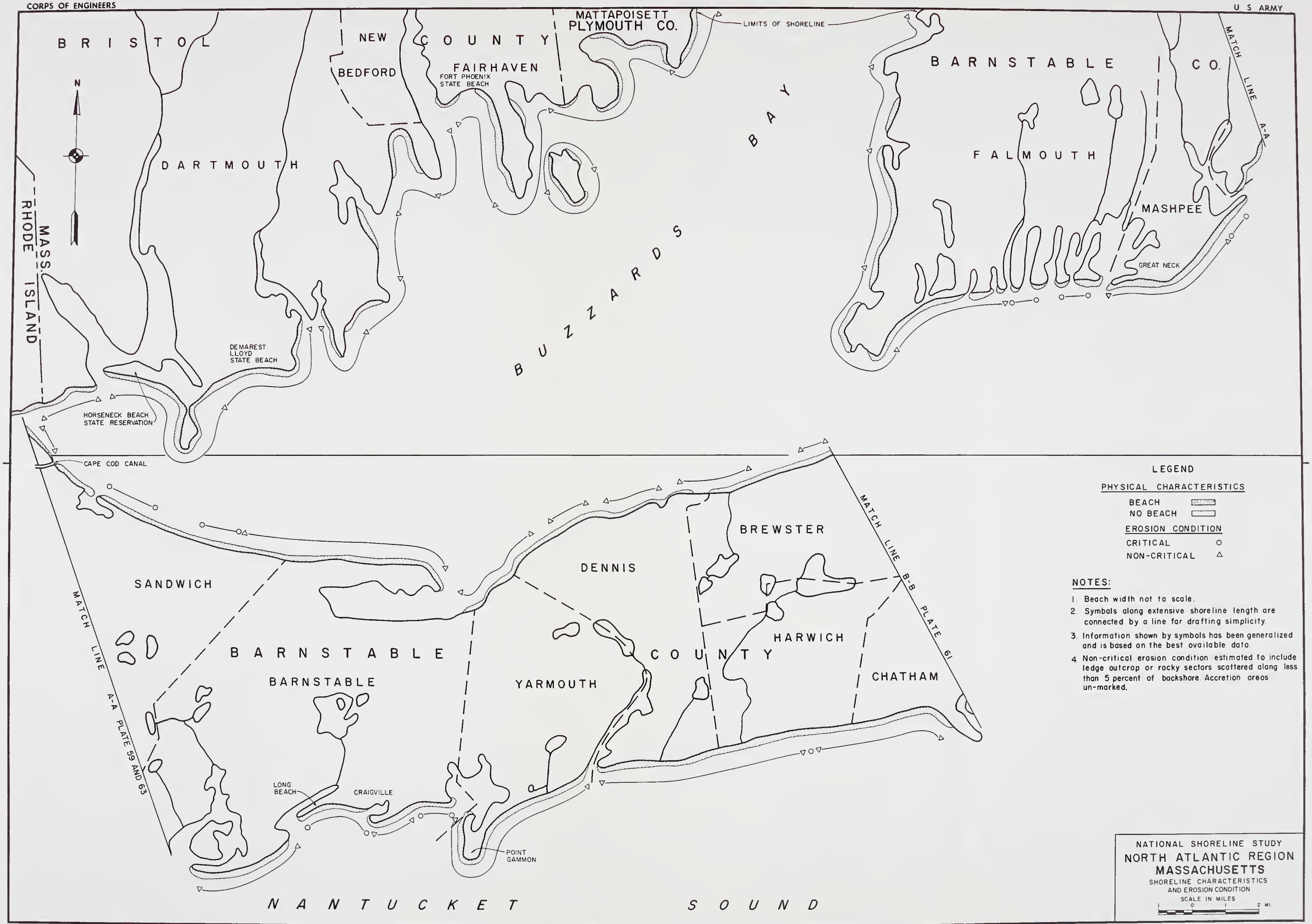

FAIRFIELD COUNTY
NEW YORK
CONN.
GREENWICH
STAMFORD
DARIEN
NORWALK
WESTPORT
FAIRFIELD
BRIDGEPORT
STRATFORD
MILFORD
BYRAM RIVER
BYRAM PT.
LITTLE CAPTAIN I.
GREENWICH PT.
SHIPPAN PT.
WEST BEACH
LONG NECK PT.
WEED BEACH
BELLE IS.
NORWALK HARBOR
SAUGATUCK SHORES
SHERWOOD ISLAND STATE PARK
LONG BEACH
HOUSATONIC R.
WOODMONT SHORE
MATCH LINE A-A
LONG ISLAND SOUND
NEW HAVEN COUNTY
MIDDLESEX COUNTY
MILFORD
WEST HAVEN
NEW HAVEN
QUINNIPIAC R.
EAST HAVEN
BRANFORD
GUILFORD
MADISON
CLINTON
WESTBROOK
OLD SAYBROOK
CONNECTICUT R.
MATCH LINE B-B
MATCH LINE A-A
CANOE HARBOR
WEST WHARF
MIDDLE BEACH
EAST WHARF
SEAVIEW INLET
GROVE BEACH
CHALKER BEACH
SAYBROOK MANOR
GREAT HAMMOCK BEACH
PLUM BANK BEACH
HAMMONASSET BEACH STATE PARK
LONG ISLAND SOUND
NEW LONDON COUNTY
CONNECTICUT R.
MATCH LINE B-B
OLD LYME
EAST LYME
NIANTIC R.
WATERFORD
NEW LONDON
GROTON
STONINGTON
THAMES R.
MYSTIC R.
PAWCATUCK R.
GRISWOLD POINT
WHITE SAND BEACH
ROCKY NECK STATE PARK
NEPTUNE PARK
OCEAN BEACH
GOSHEN COVE
BUSHY POINT BEACH
HARKNESS MEMORIAL STATE PARK
TO FISHER'S ISLAND
CONN.
N.Y.
R.I.
LONG ISLAND SOUND
BLOCK ISLAND SOUND
SUFFOLK CO.
SOUTH OLD
FISHER'S ISLAND
NOT TO SCALE
LEGEND
OWNERSHIP
FEDERAL
NON-FEDERAL PUBLIC
PRIVATE
USE
PUBLIC RECREATIONAL
PRIVATE RECREATIONAL
NON-RECREATIONAL DEVELOPMENT
UNDEVELOPED
NOTES:
1. Symbols along extensive shoreline length are connected by o line for drafting simplicity.
2. Information shown by symbols has been generalized and is based on the best available data.
3. Cross hatched areas represent heavy urban development.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
CONNECTICUT
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
0
2 MI.

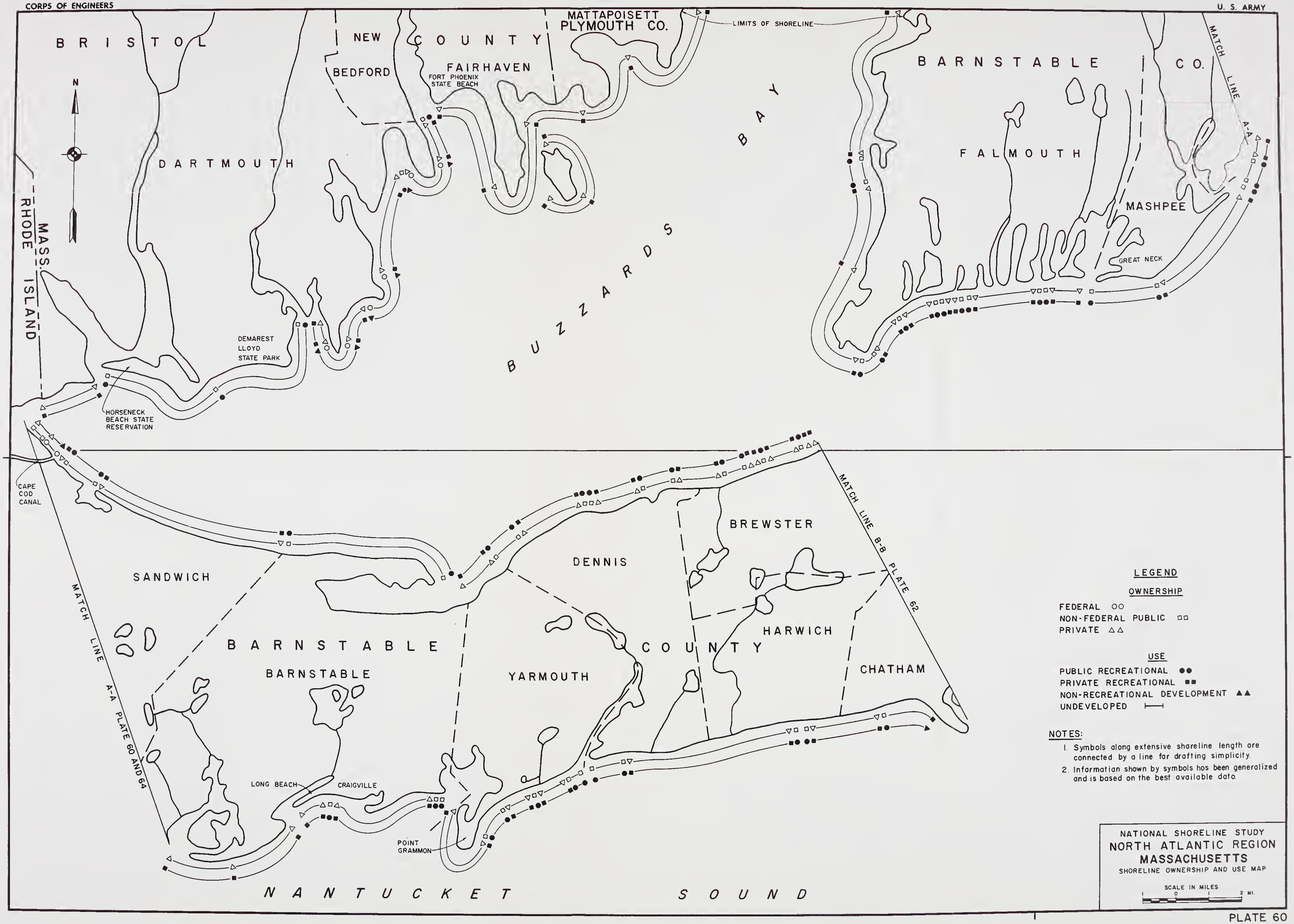

WASHINGTON COUNTY
R.I.
CONN.
CHARLESTOWN
KINGSTOWN
WESTERLY
PAWCATUCK R.
WINNAPAUG POND
QUONACHONTAUG POND
NINIGRET POND
MISQUAMICUT BEACH
NAPATREE BEACH
MATUNUCK BEACH
POINT JUDITH POND
NARRAGANSETT
PT. JUDITH
SAND HILL COVE BEACH
MATCH LINE A-A
BLOCK ISLAND SOUND
N
VICINITY MAP
MASS.
R.I.
CONNECTICUT
RHODE ISLAND
Scituate Res.
PROVIDENCE
Taunton R.
Pachaug Lake
NARRAGANSETT BAY
PORTSMOUTH
SAKONNET PT.
PT. JUDITH
FISHERS I.
BLOCK IS.
SCALE IN MILES
10 0 10 20
LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL ○
NON-CRITICAL △
NOTES:
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
4. Cross hatched areas represent heavy urban development
5. Non-critical erosion condition estimated to include ledge outcrop or rocky sectors scattered along 30 percent of outer exposed backshore (excluding Block Island). Accretion areas un-marked.
NARRAGANSETT BAY
NEWPORT COUNTY
WASHINGTON COUNTY
PORTSMOUTH
NORTH KINGSTON
JAMESTOWN
MIDDLETOWN
NEWPORT
CLIFF WALK
SAKONNET RIVER
TIVERTON
MASS.
R.I.
LITTLE COMPTON
MATCH LINE A-A
NARRAGANSETT
BLOCK ISLAND SOUND
BLOCK ISLAND SOUND
RHODE ISLAND SOUND
COW COVE
GREAT SALT POND
BLOCK ISLAND
NEWPORT COUNTY
ATLANTIC OCEAN
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
RHODE ISLAND
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2 MI.

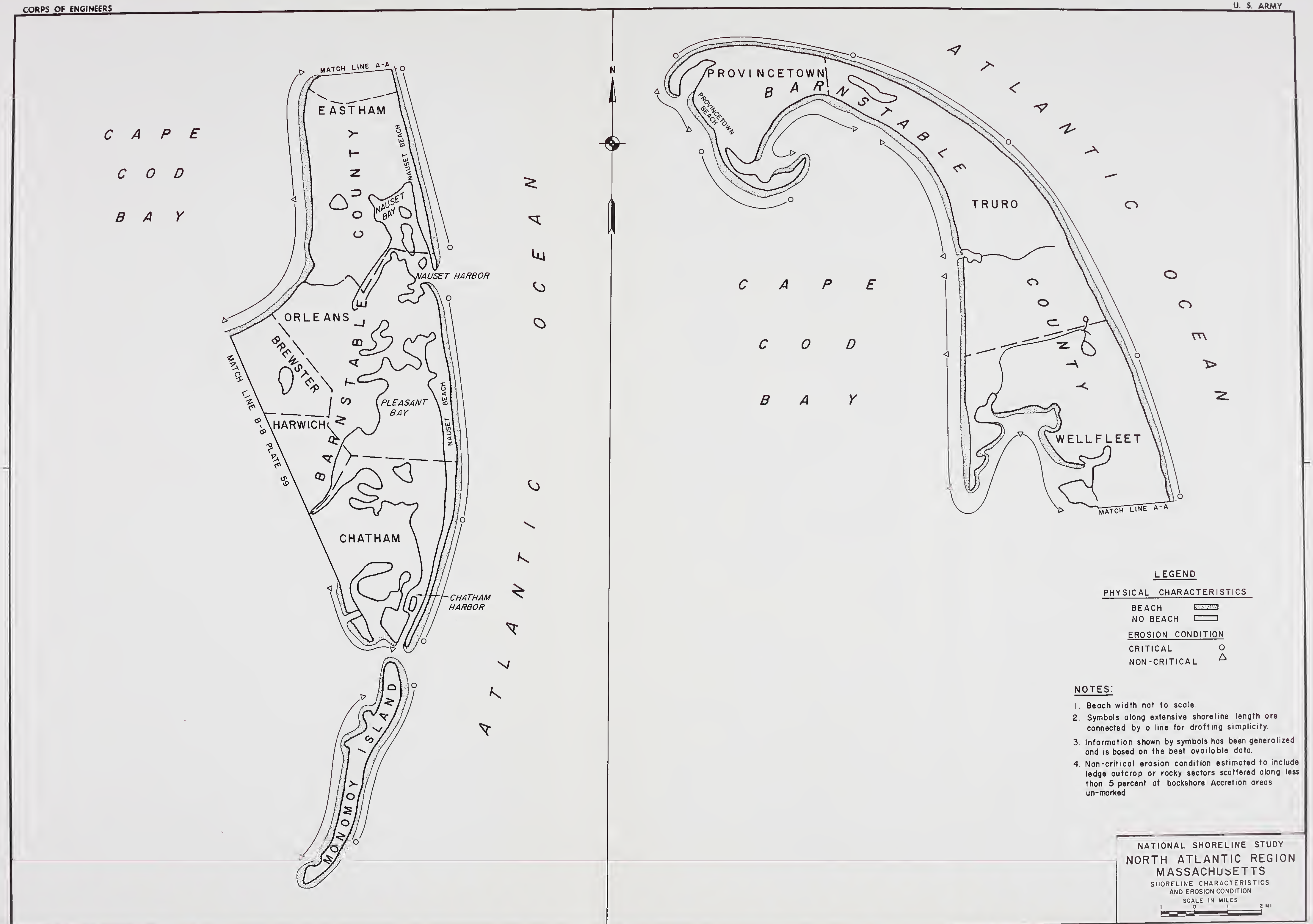

R. I.
CONN.
WASHINGTON COUNTY
CHARLESTOWN
KINGSTOWN
WESTERLY
NARRAGANSETT
MATCH LINE A-A
MATUNUCK BEACH
POINT JUDITH POND
PT. JUDITH
NINIGRET POND
QUONACHONTAUG POND
WINNAPAUG POND
PAWCATUCK R.
MISQUAMICUT BEACH
NAPATREE BEACH
BLOCK ISLAND SOUND
VICINITY MAP
MASS.
R. I.
CONNECTICUT
RHODE ISLAND
Scituate Res.
PROVIDENCE
Taunton R.
Pachaug Lake
NARRAGANSETT BAY
PORTSMOUTH
SAKONNET PT.
PT JUDITH
FISHERS I.
BLOCK IS
SCALE IN MILES
10 0 10 20
NARRAGANSETT BAY
NEWPORT COUNTY
WASHINGTON COUNTY
PORTSMOUTH
SAKONNET RIVER
TIVERTON
R. I.
MASS.
NORTH KINGSTON
JAMESTOWN
MIDDLETOWN
LITTLE COMPTON
NEWPORT
CLIFF WALK
NARRAGANSETT
MATCH LINE A-A
BLOCK ISLAND SOUND
BLOCK ISLAND SOUND
RHODE ISLAND SOUND
COW COVE
GREAT SALT POND
BLOCK ISLAND
NEWPORT COUNTY
ATLANTIC OCEAN
LEGEND
OWNERSHIP
FEDERAL
NON-FEDERAL PUBLIC
PRIVATE
USE
PUBLIC RECREATIONAL
PRIVATE RECREATIONAL
NON-RECREATIONAL DEVELOPMENT
UNDEVELOPED
NOTES:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
2. Information shown by symbols has been generalized and is based on the best available data.
3. Cross hatched areas represent heavy urban development.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
RHODE ISLAND
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2 MI.

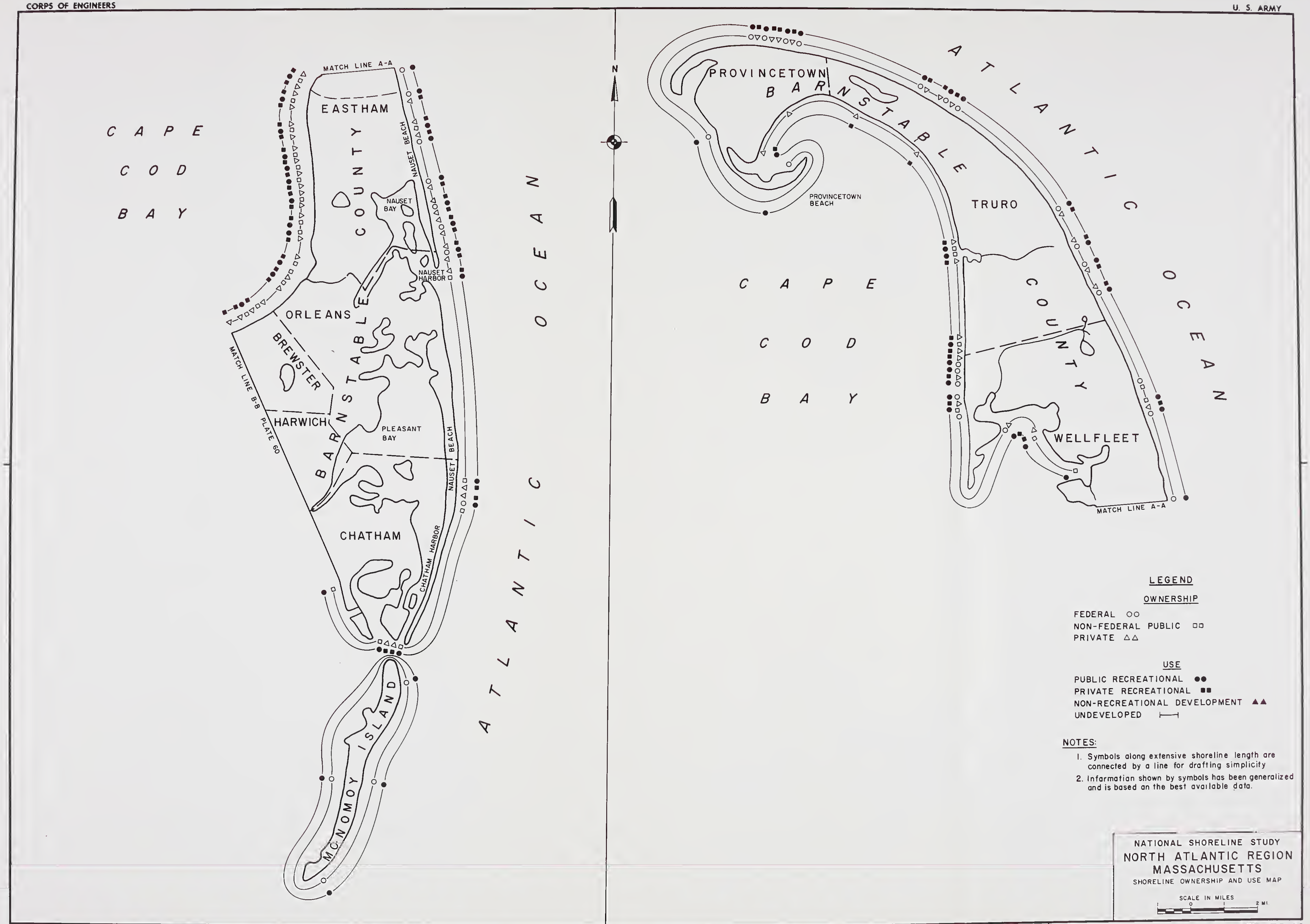

BUZZARDS BAY
NOBSKA PT
NANTUCKET SOUND
ELIZABETH ISLANDS
GOSNOLD
CUTTYHUNK HARBOR
CUTTYHUNK ISLAND
VINEYARD SOUND
VINEYARD HAVEN HARBOR
WEST CHOP
EAST CHOP
OAK BLUFFS HARBOR
TISBURY
OAK BLUFFS
WEST TISBURY
MARTHA'S VINEYARD
EDGARTOWN HARBOR
CAPE POGE BAY
EDGARTOWN
DUKES COUNTY
CHAPPAQUIDICK ISLAND
KATAMA BAY
CHILMARK
GAY HEAD CLIFFS
GAY HEAD
MUSKEGET CHANNEL
ATLANTIC OCEAN
NANTUCKET SOUND
GREAT POINT
MUSKEGET I.
NO MAN'S LAND
TUCKERNOCK ISLAND
SMITH POINT
MADAKET HARBOR
MADAKET
NANTUCKET
NANTUCKET HARBOR
COUNTY
NANTUCKET ISLAND
SIASCONSET
ATLANTIC OCEAN
N
BOSTON
ATLANTIC OCEAN
CAPE COO BAY
CAPE COO
BUZZARDS BAY
NANTUCKET SOUND
Elizabeth Is.
Nantucket I.
Martha's Vineyard
VICINITY MAP
SCALE IN MILES
10 0 10 20 30 40
LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
NOTES:
1. Beoch width not to scole.
2. Symbols olong extensive shoreline length ore connected by o line for drofting simplicity.
3. Information shown by symbols has been generolized ond is based on the best avoiloble doto.
4. Non-criticol erosion condition estimoted to include less thon 1 percent of shorefront os rocky bock-shore oreos. Accretion oreos un-morked.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MASSACHUSETTS
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 2 MI

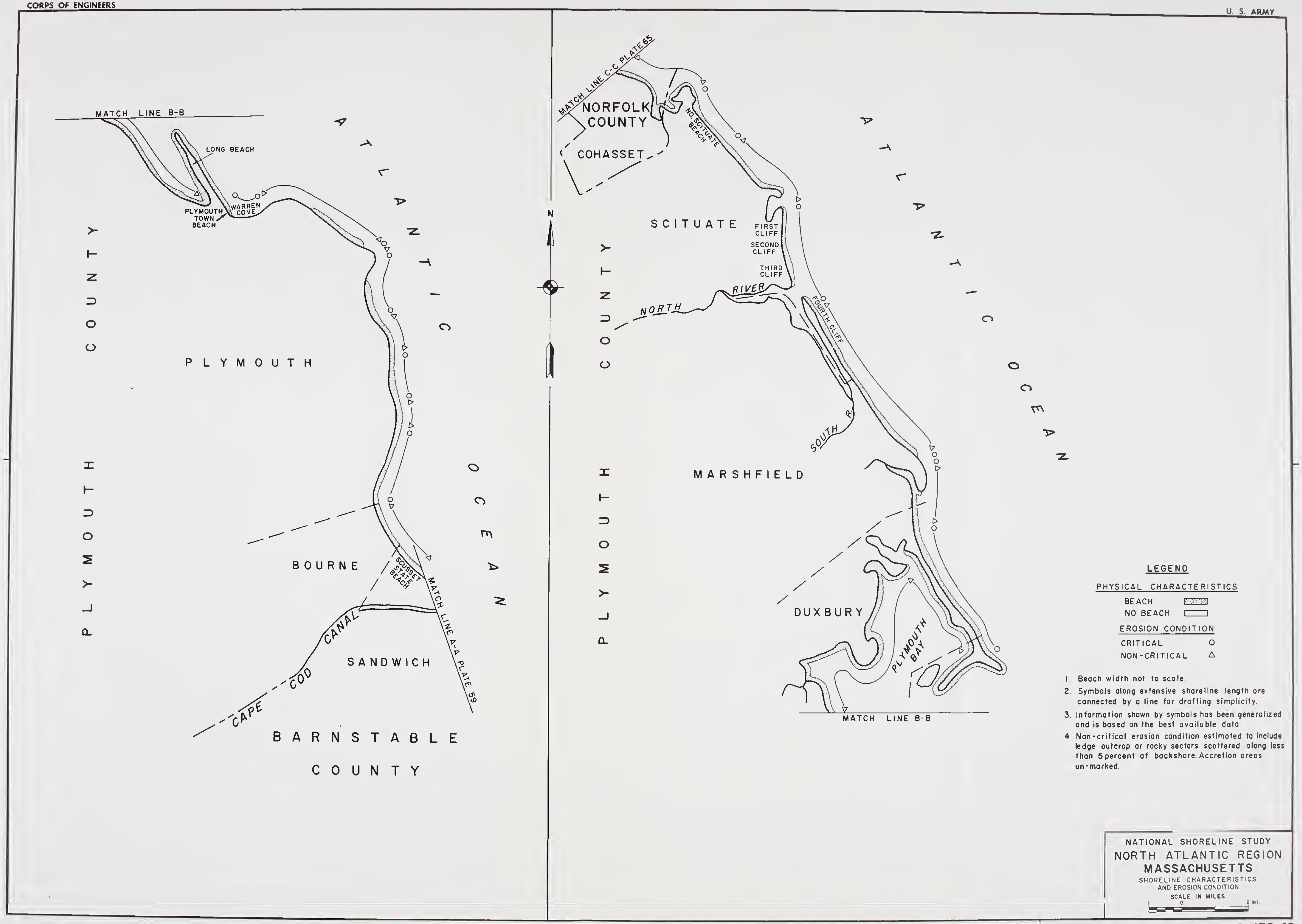

BUZZARDS BAY
ELIZABETH ISLANDS
GOSNOLD
CUTTYHUNK
NOBSKA PT.
NANTUCKET SOUND
VINEYARD SOUND
VINEYARD HAVEN HARBOR
WEST CHOP
EAST CHOP
OAK BLUFFS HARBOR
TISBURY
OAK BLUFFS
WEST TISBURY
MARTHA'S VINEYARD
EDGARTOWN
EDGARTOWN HARBOR
CAPE POGE BAY
CHAPPAQUIDICK ISLAND
KATAMA BAY
DUKES COUNTY
CHILMARK
GAY HEAD CLIFFS
GAY HEAD
MUSKEGET CHANNEL
ATLANTIC OCEAN
NANTUCKET SOUND
GREAT POINT
MUSKEGET I
NO MAN'S LAND
TUCKERNOCK ISLAND
SMITH PT
MADAKET HARBOR
MADAKET
NANTUCKET
NANTUCKET HARBOR
COUNTY
NANTUCKET ISLAND
SIASCONSET
ATLANTIC OCEAN
N
BOSTON
ATLANTIC OCEAN
CAPE COD BAY
CAPE COD
BUZZARDS BAY
Elizabeth Is.
NANTUCKET SOUND
Martha's Vineyard
Nantucket I.
VICINITY MAP
SCALE IN MILES
10 0 10 20 30 40
LEGEND
OWNERSHIP
FEDERAL ○○
NON-FEDERAL PUBLIC □□
PRIVATE △△
USE
PUBLIC RECREATIONAL ●●
PRIVATE RECREATIONAL ■■
NON-RECREATIONAL DEVELOPMENT ▲▲
UNDEVELOPED
NOTES:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
2. Information shown by symbols has been generalized and is based on the best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MASSACHUSETTS
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2 MI.

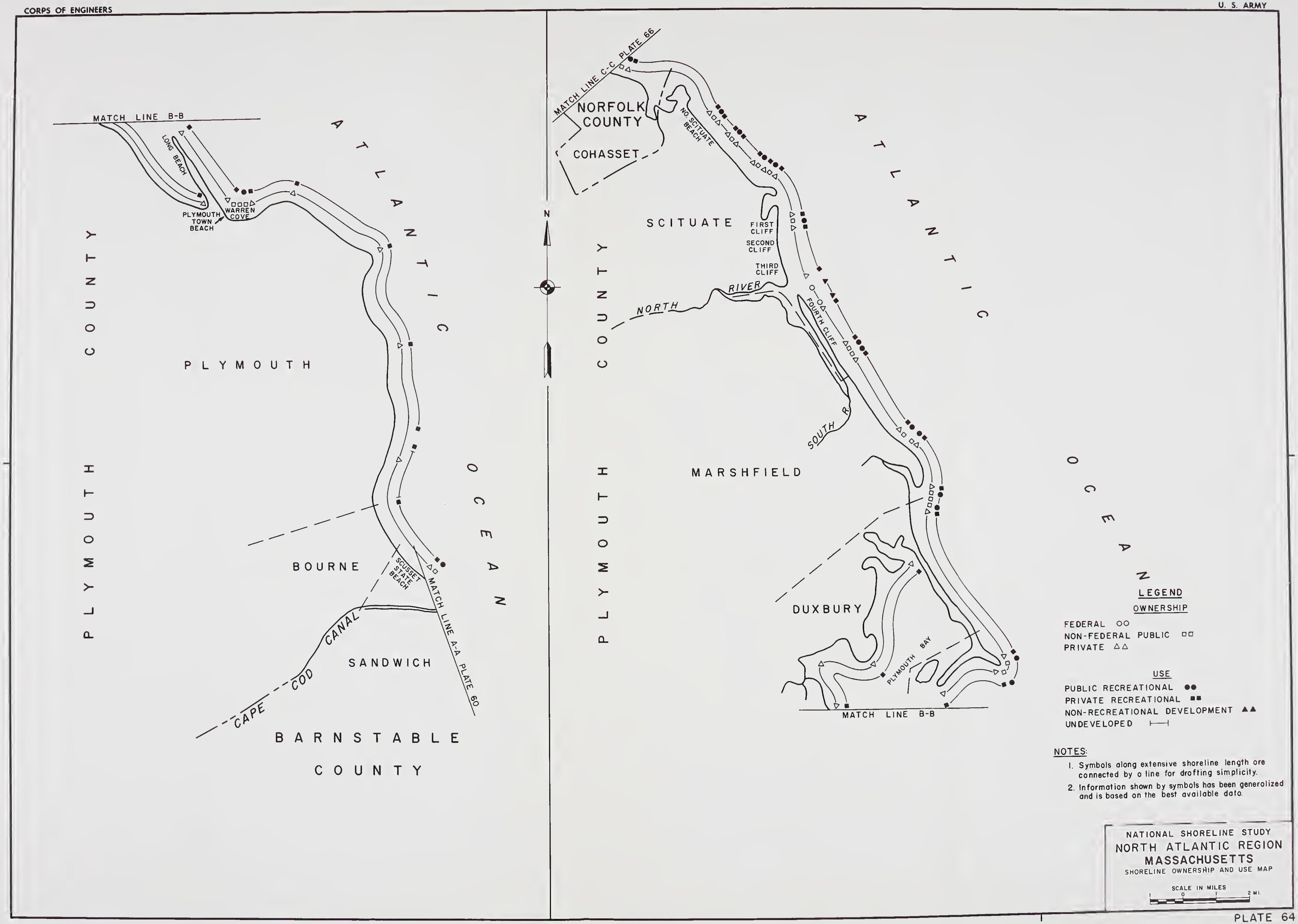

BRISTOL COUNTY
NEW BEDFORD
FAIRHAVEN
FORT PHOENIX STATE BEACH
MATTAPOISETT
PLYMOUTH CO.
LIMITS OF SHORELINE
BARNSTABLE CO.
MATCH LINE A-A
FALMOUTH
MASHPEE
GREAT NECK
N
DARTMOUTH
RHODE ISLAND
MASS.
BUZZARDS BAY
DEMAREST LLOYD STATE BEACH
HORSENECK BEACH STATE RESERVATION
CAPE COD CANAL
SANDWICH
MATCH LINE A-A PLATE 59 AND 63
BARNSTABLE COUNTY
BARNSTABLE
YARMOUTH
DENNIS
BREWSTER
HARWICH
CHATHAM
MATCH LINE B-B PLATE 61
LONG BEACH
CRAIGVILLE
POINT GAMMON
NANTUCKET SOUND
LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
NOTES:
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
4. Non-critical erosion condition estimated to include ledge outcrop or rocky sectors scattered along less than 5 percent of backshore. Accretion areas un-marked.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MASSACHUSETTS
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2 MI.

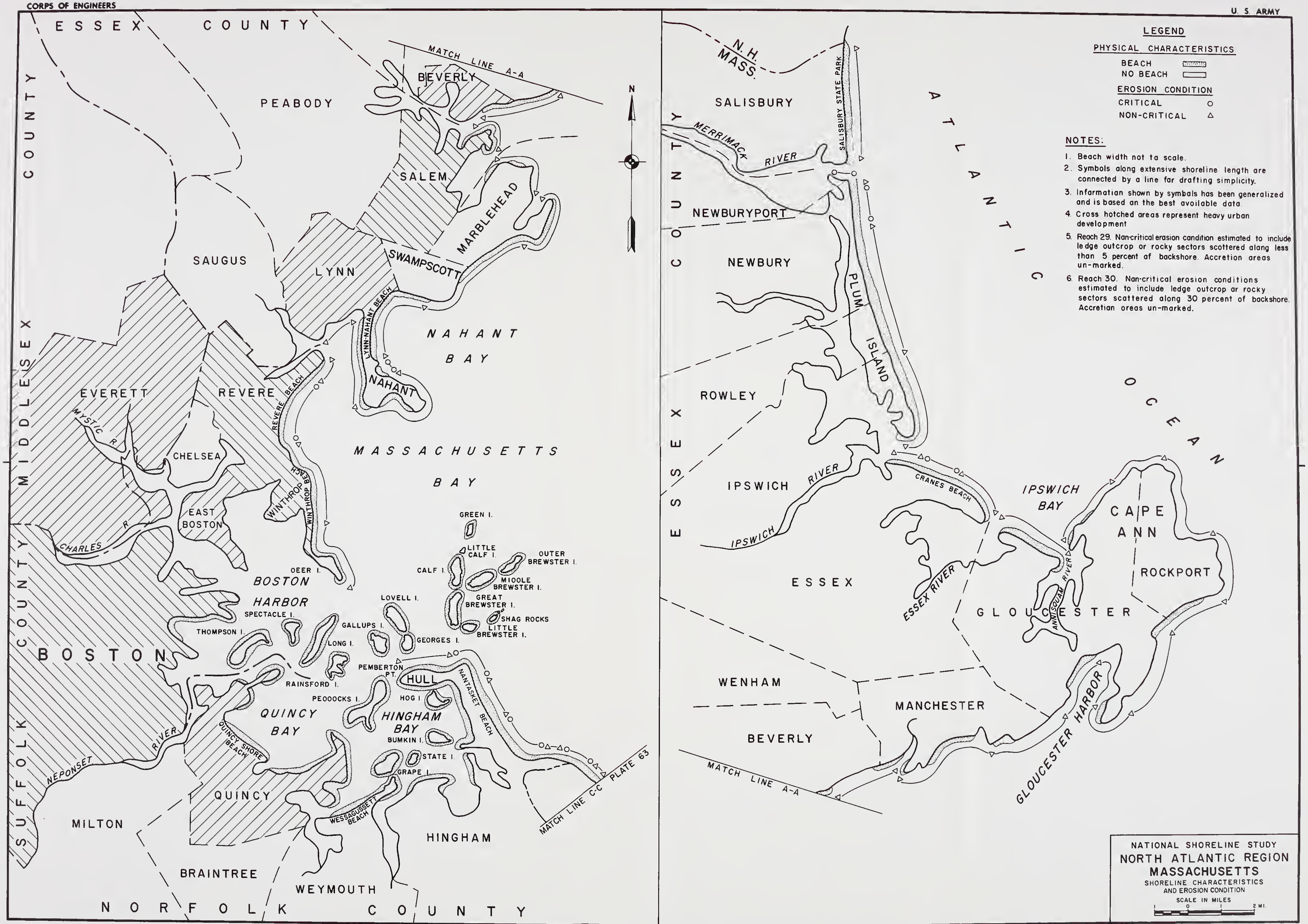

BRISTOL
NEW BEDFORD
COUNTY
FAIRHAVEN
FORT PHOENIX STATE BEACH
MATTAPOISETT
PLYMOUTH CO.
LIMITS OF SHORELINE
BARNSTABLE CO.
MATCH LINE A-A
N
DARTMOUTH
FALMOUTH
MASHPEE
GREAT NECK
BUZZARDS BAY
RHODE ISLAND
MASS.
DEMAREST LLOYD STATE PARK
HORSENECK BEACH STATE RESERVATION
CAPE COD CANAL
BREWSTER
MATCH LINE B-B PLATE 62
DENNIS
SANDWICH
MATCH LINE A-A PLATE 60 AND 64
BARNSTABLE
BARNSTABLE
COUNTY
HARWICH
YARMOUTH
CHATHAM
LONG BEACH
CRAIGVILLE
POINT GRAMMON
NANTUCKET SOUND
LEGEND
OWNERSHIP
FEDERAL
NON-FEDERAL PUBLIC
PRIVATE
USE
PUBLIC RECREATIONAL
PRIVATE RECREATIONAL
NON-RECREATIONAL DEVELOPMENT
UNDEVELOPED
NOTES:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
2. Information shown by symbols has been generalized and is based on the best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MASSACHUSETTS
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2 MI.

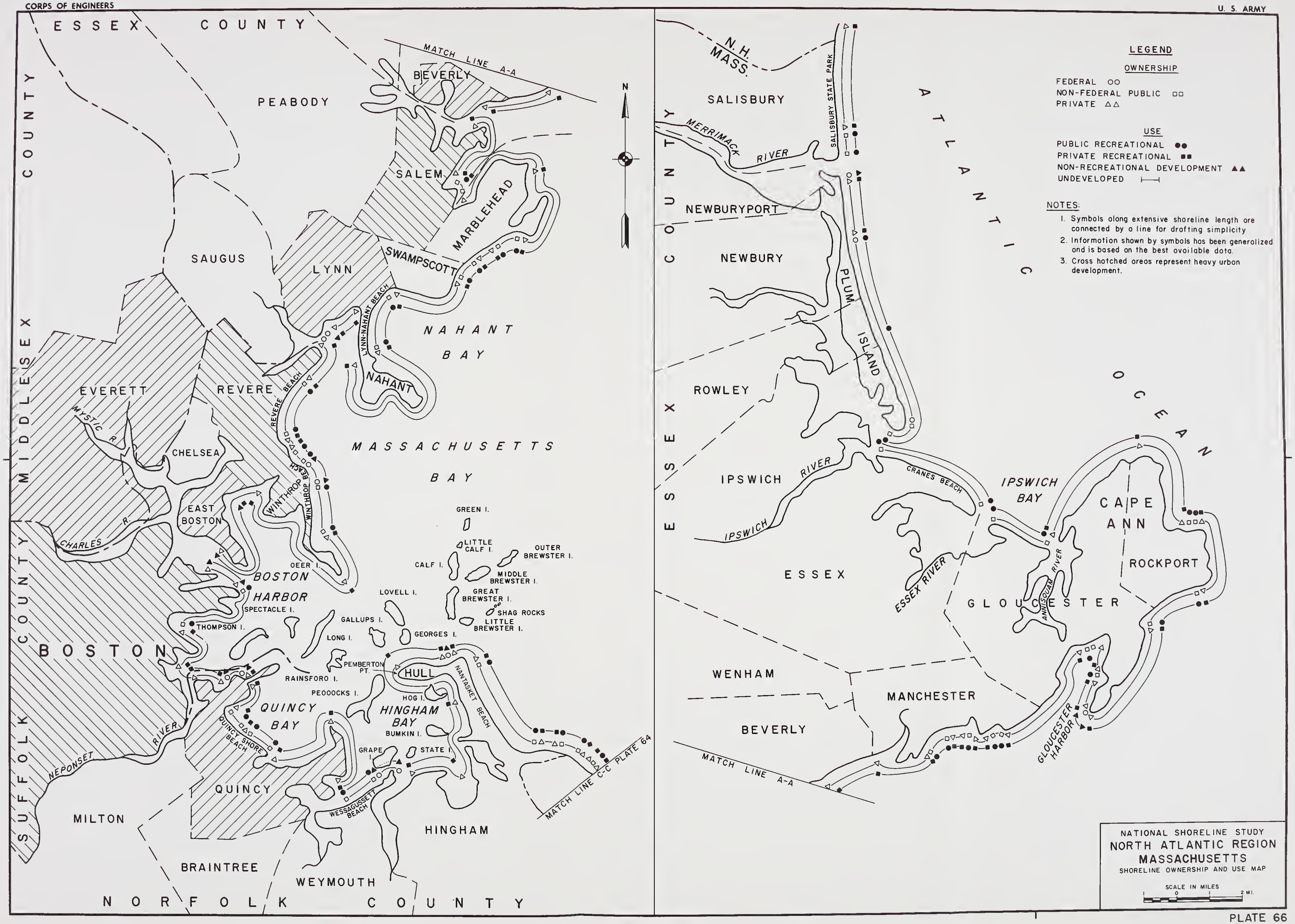

MATCH LINE A-A
EASTHAM
CAPE COD BAY
BARNSTABLE COUNTY
NAUSET BEACH
NAUSET BAY
NAUSET HARBOR
ORLEANS
BREWSTER
HARWICH
MATCH LINE B-B PLATE 59
PLEASANT BAY
CHATHAM
CHATHAM HARBOR
MONOMOY ISLAND
ATLANTIC OCEAN
N
PROVINCETOWN
PROVINCETOWN BEACH
BARNSTABLE
TRURO
CAPE COD BAY
COUNTY
WELLFLEET
MATCH LINE A-A
ATLANTIC OCEAN
LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
NOTES:
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
4. Non-critical erosion condition estimated to include ledge outcrop or rocky sectors scattered along less than 5 percent of backshore. Accretion areas un-marked.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MASSACHUSETTS
SHORELINE CHARACTERISTICS
AND EROSION CONDITION
SCALE IN MILES
1 0 1 2 MI


CAPE COD BAY
MATCH LINE A-A
EASTHAM
NAUSET BEACH
NAUSET BAY
NAUSET HARBOR
BARNSTABLE COUNTY
ORLEANS
BREWSTER
HARWICH
MATCH LINE B-B PLATE 60
PLEASANT BAY
NAUSET BEACH
CHATHAM
CHATHAM HARBOR
MONOMOY ISLAND
ATLANTIC OCEAN
N
PROVINCETOWN
BARNSTABLE
PROVINCETOWN BEACH
ATLANTIC OCEAN
CAPE COD BAY
TRURO
COUNTY
WELLFLEET
MATCH LINE A-A
LEGEND
OWNERSHIP
FEDERAL ○○
NON-FEDERAL PUBLIC □□
PRIVATE △△
USE
PUBLIC RECREATIONAL ●●
PRIVATE RECREATIONAL ■■
NON-RECREATIONAL DEVELOPMENT ▲▲
UNDEVELOPED ⊢⊣
NOTES:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity
2. Information shown by symbols has been generalized and is based on the best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MASSACHUSETTS
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2 MI.


MATCH LINE B-B
LONG BEACH
PLYMOUTH TOWN BEACH
WARREN COVE
ATLANTIC OCEAN
PLYMOUTH COUNTY
PLYMOUTH
BOURNE
SCUSSET STATE BEACH
MATCH LINE A-A PLATE 59
CAPE COD CANAL
SANDWICH
BARNSTABLE COUNTY
N
MATCH LINE C-C PLATE 65
NORFOLK COUNTY
COHASSET
NO. SCITUATE BEACH
SCITUATE
FIRST CLIFF
SECOND CLIFF
THIRD CLIFF
NORTH RIVER
FOURTH CLIFF
SOUTH R
MARSHFIELD
DUXBURY
PLYMOUTH BAY
MATCH LINE B-B
LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
4. Non-critical erosion condition estimated to include ledge outcrop or rocky sectors scattered along less than 5 percent of backshore. Accretion areas un-marked.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MASSACHUSETTS
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2 MI.


MATCH LINE B-B
LONG BEACH
PLYMOUTH TOWN BEACH
WARREN COVE
ATLANTIC OCEAN
PLYMOUTH COUNTY
PLYMOUTH
BOURNE
SCUSSET STATE BEACH
MATCH LINE A-A PLATE 60
CAPE COD CANAL
SANDWICH
BARNSTABLE COUNTY
N
MATCH LINE C-C PLATE 66
NORFOLK COUNTY
COHASSET
NO. SCITUATE BEACH
SCITUATE
FIRST CLIFF
SECOND CLIFF
THIRD CLIFF
NORTH RIVER
FOURTH CLIFF
SOUTH R.
MARSHFIELD
DUXBURY
PLYMOUTH BAY
LEGEND
OWNERSHIP
FEDERAL ○○
NON-FEDERAL PUBLIC □□
PRIVATE △△
USE
PUBLIC RECREATIONAL ●●
PRIVATE RECREATIONAL ■■
NON-RECREATIONAL DEVELOPMENT ▲▲
UNDEVELOPED
NOTES:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
2. Information shown by symbols has been generalized and is based on the best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MASSACHUSETTS
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2 MI.


LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
NOTES:
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
4. Cross hatched areas represent heavy urban development.
5. Reach 29. Non-critical erosion condition estimated to include ledge outcrop or rocky sectors scattered along less than 5 percent of backshore. Accretion areas un-marked.
6. Reach 30. Non-critical erosion conditions estimated to include ledge outcrop or rocky sectors scattered along 30 percent of backshore. Accretion areas un-marked.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MASSACHUSETTS
SHORELINE CHARACTERISTICS
AND EROSION CONDITION
SCALE IN MILES
0
1
2 MI.
ESSEX COUNTY
MIDDLESEX COUNTY
SUFFOLK COUNTY
NORFOLK COUNTY
MATCH LINE A-A
MATCH LINE C-C PLATE 63
N
BEVERLY
PEABODY
SALEM
MARBLEHEAD
SAUGUS
LYNN
SWAMPSCOTT
LYNN-NAHANT BEACH
NAHANT BAY
NAHANT
EVERETT
REVERE
REVERE BEACH
MYSTIC R.
CHELSEA
WINTHROP
WINTHROP BEACH
EAST BOSTON
CHARLES R.
MASSACHUSETTS BAY
BOSTON HARBOR
DEER I.
GREEN I.
LITTLE CALF I.
OUTER BREWSTER I.
CALF I.
MIDDLE BREWSTER I.
GREAT BREWSTER I.
SHAG ROCKS
LITTLE BREWSTER I.
LOVELL I.
SPECTACLE I.
THOMPSON I.
GALLUPS I.
LONG I.
GEORGES I.
BOSTON
PEMBERTON PT.
HULL
NANTASKET BEACH
RAINSFORD I.
PEDDOCKS I.
HOG I.
QUINCY BAY
HINGHAM BAY
BUMKIN I.
STATE I.
GRAPE I.
QUINCY SHORE BEACH
NEPONSET RIVER
QUINCY
WESSAGUSSETT BEACH
MILTON
HINGHAM
BRAINTREE
WEYMOUTH
N.H.
MASS.
SALISBURY
SALISBURY STATE PARK
MERRIMACK RIVER
NEWBURYPORT
NEWBURY
PLUM ISLAND
ROWLEY
ATLANTIC OCEAN
IPSWICH
IPSWICH RIVER
CRANES BEACH
IPSWICH BAY
CAPE ANN
ROCKPORT
ESSEX
ESSEX RIVER
ANNISQUAM RIVER
GLOUCESTER
WENHAM
MANCHESTER
GLOUCESTER HARBOR


ESSEX COUNTY
MIDDLESEX COUNTY
SUFFOLK COUNTY
NORFOLK COUNTY
MATCH LINE A-A
PEABODY
BEVERLY
SALEM
MARBLEHEAD
SAUGUS
LYNN
SWAMPSCOTT
LYNN-NAHANT BEACH
NAHANT BAY
NAHANT
EVERETT
REVERE
REVERE BEACH
MYSTIC R.
CHELSEA
MASSACHUSETTS BAY
EAST BOSTON
WINTHROP BEACH
CHARLES R.
BOSTON HARBOR
DEER I.
GREEN I.
LITTLE CALF I.
OUTER BREWSTER I.
CALF I.
MIDDLE BREWSTER I.
GREAT BREWSTER I.
SHAG ROCKS
LITTLE BREWSTER I.
LOVELL I.
SPECTACLE I.
GALLUPS I.
THOMPSON I.
LONG I.
GEORGES I.
BOSTON
PEMBERTON PT.
HULL
RAINSFORD I.
PEDDOCKS I.
HOG I.
NANTASKET BEACH
QUINCY BAY
HINGHAM BAY
BUMKIN I.
QUINCY SHORE BEACH
NEPONSET RIVER
GRAPE I.
STATE I.
MATCH LINE C-C PLATE 64
QUINCY
WESSAGUSSETT BEACH
MILTON
HINGHAM
BRAINTREE
WEYMOUTH
N.H.
MASS.
SALISBURY
SALISBURY STATE PARK
MERRIMACK RIVER
ATLANTIC OCEAN
NEWBURYPORT
NEWBURY
PLUM ISLAND
ROWLEY
IPSWICH
IPSWICH RIVER
CRANES BEACH
IPSWICH BAY
CAPE ANN
ESSEX
ESSEX RIVER
ANNISQUAM RIVER
ROCKPORT
GLOUCESTER
WENHAM
MANCHESTER
BEVERLY
GLOUCESTER HARBOR
LEGEND
OWNERSHIP
FEDERAL
NON-FEDERAL PUBLIC
PRIVATE
USE
PUBLIC RECREATIONAL
PRIVATE RECREATIONAL
NON-RECREATIONAL DEVELOPMENT
UNDEVELOPED
NOTES:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity
2. Information shown by symbols has been generalized and is based on the best available data.
3. Cross hatched areas represent heavy urban development.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MASSACHUSETTS
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1 0 1 2 MI.

LEGEND

PHYSICAL CHARACTERISTICS

BEACH
NO BEACH

EROSION CONDITION

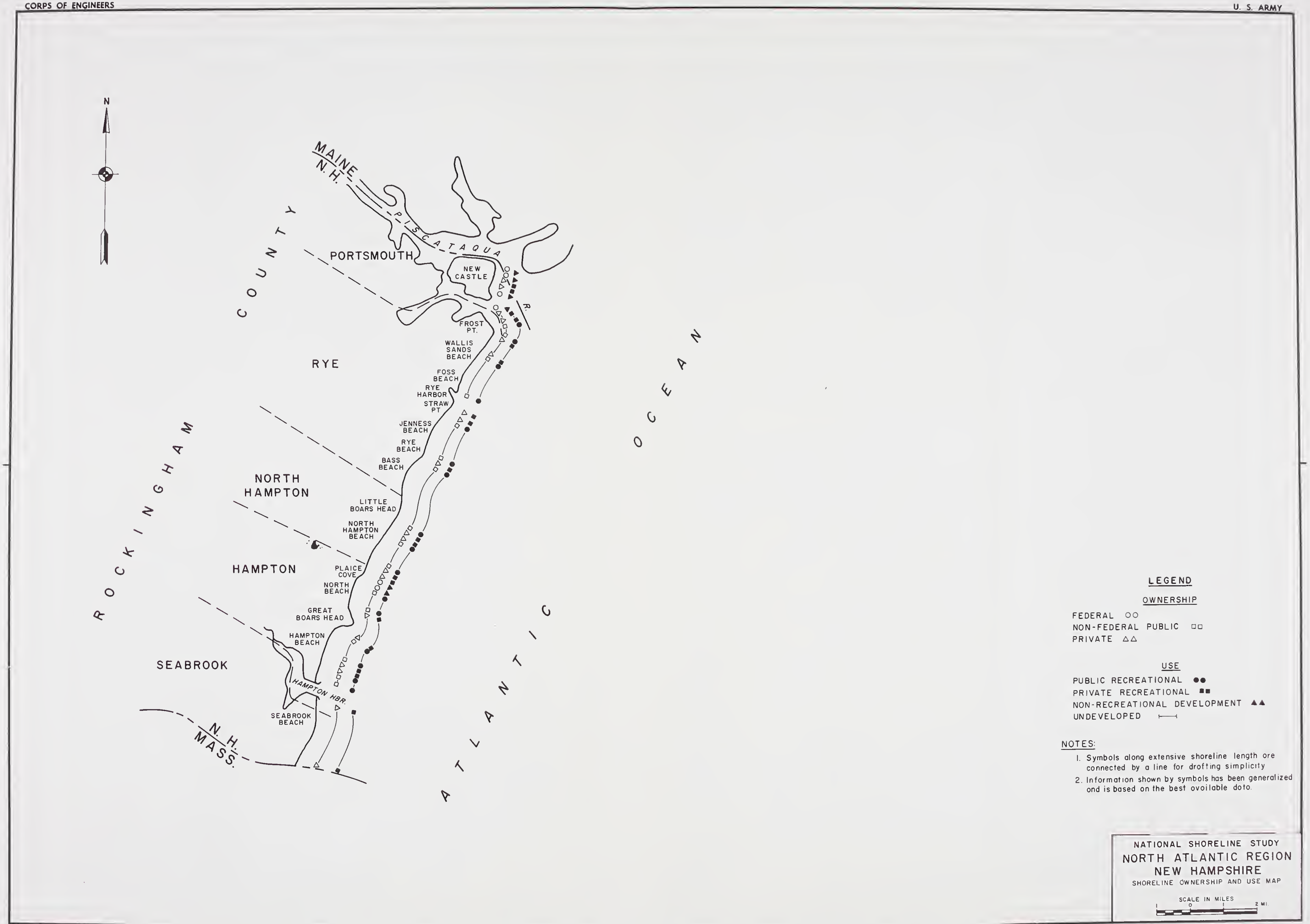
CRITICAL ○
NON-CRITICAL △

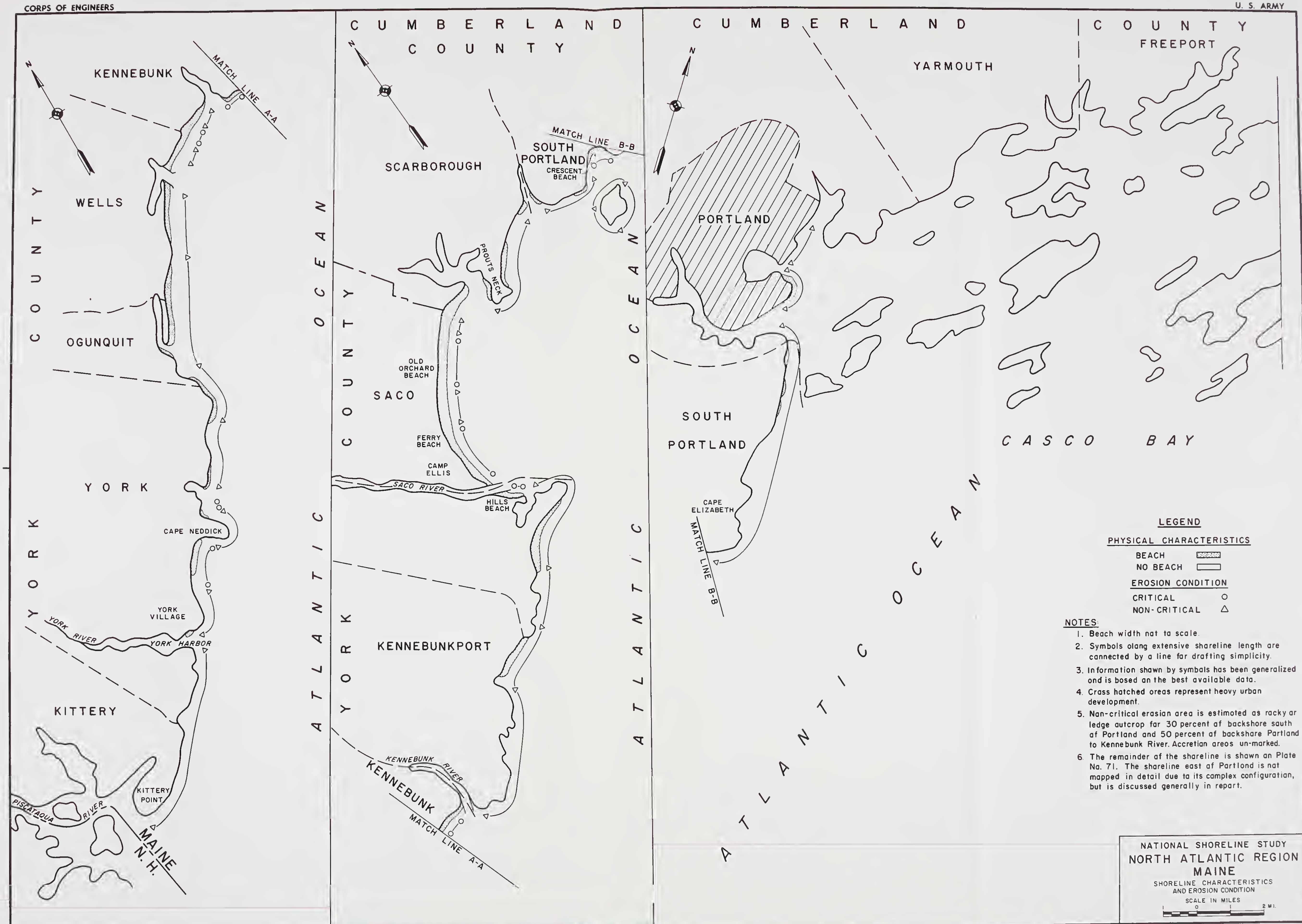
NOTES:

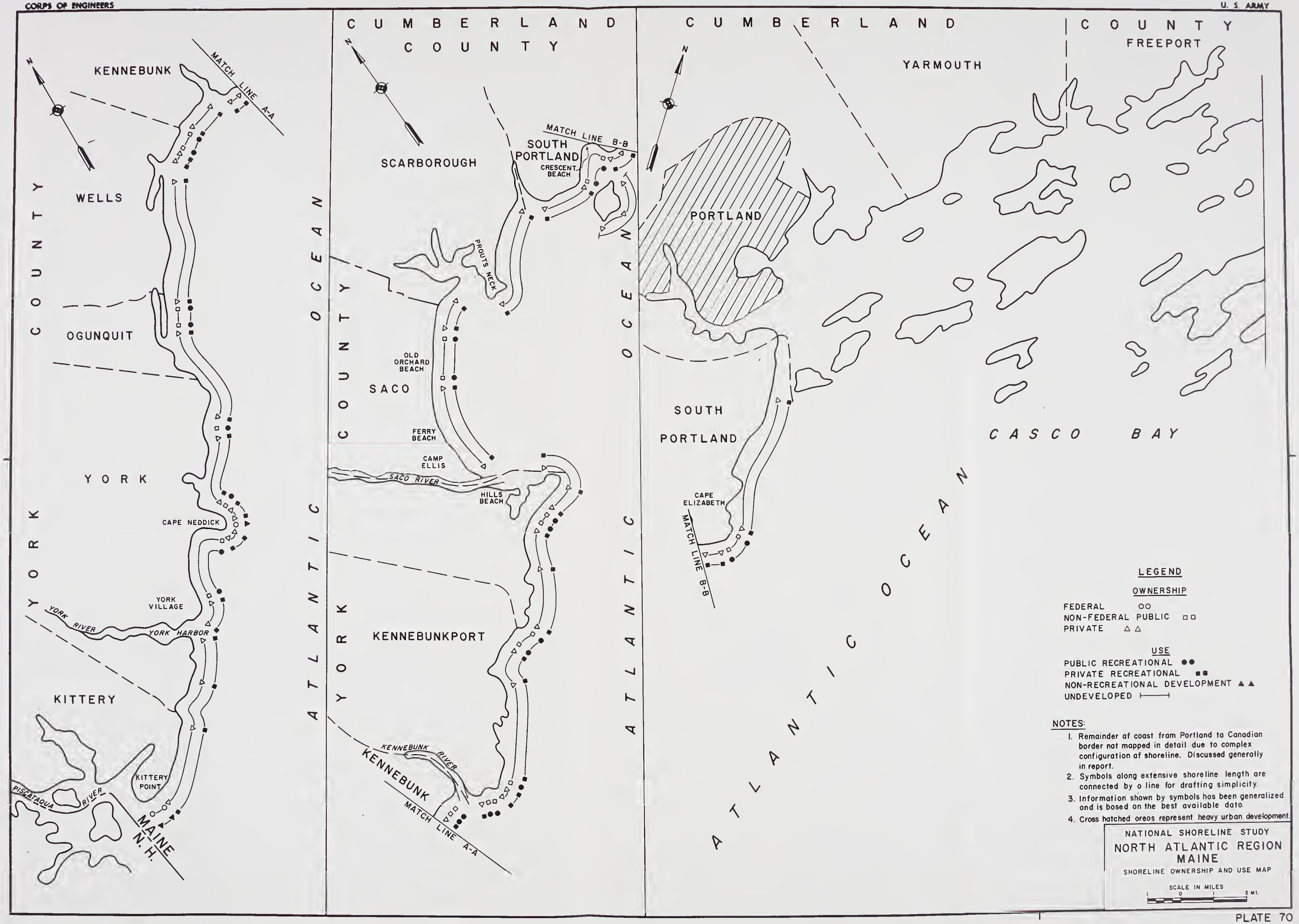
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
4. Non-critical erosion condition estimated to include ledge outcrop or rocky sectors along 50 percent of backshore. Accretion areas un-marked.

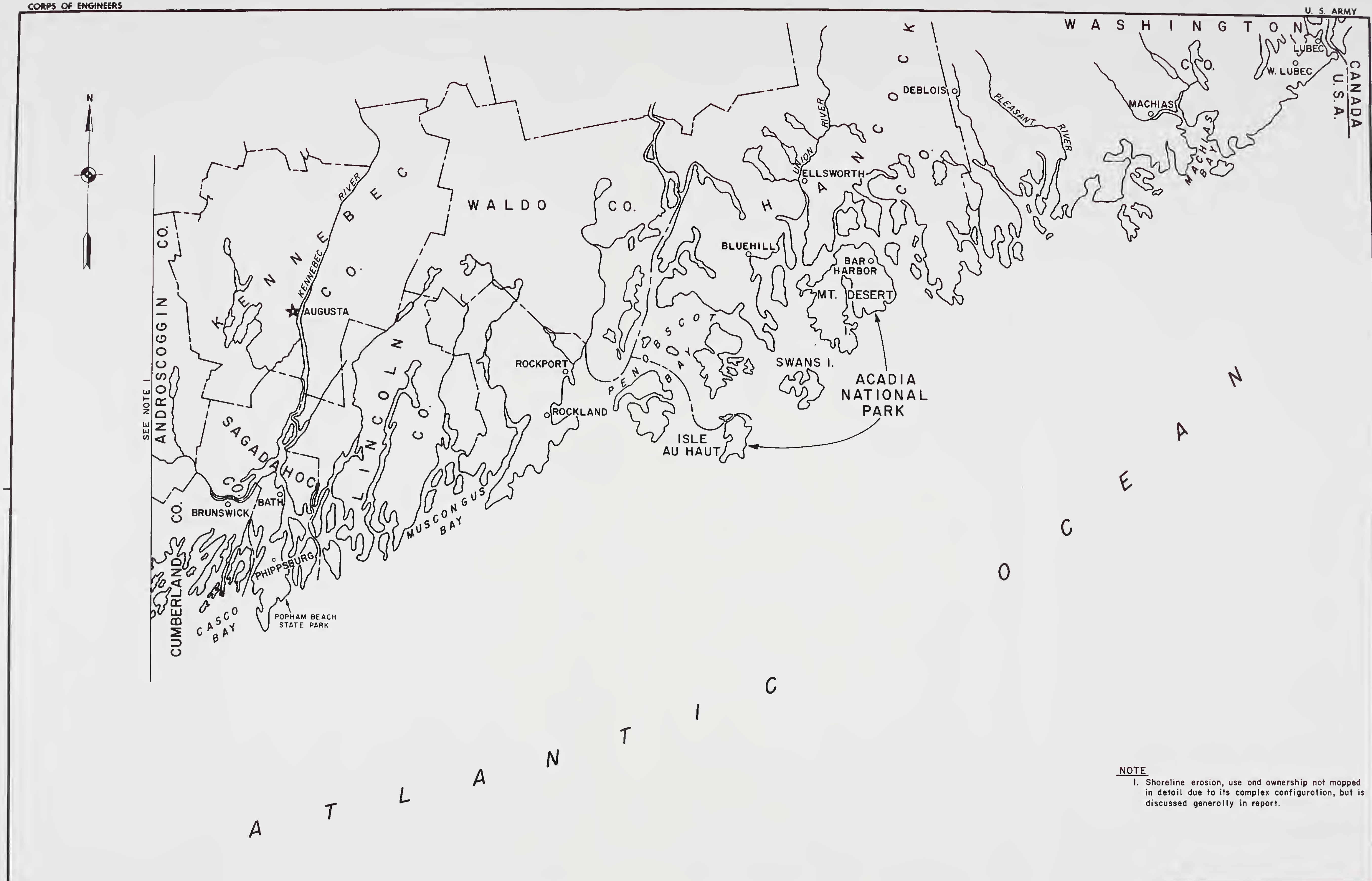
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW HAMPSHIRE
SHORELINE CHARACTERISTICS AND EROSION CONDITION

SCALE IN MILES
1 0 1 2 MI.


N
MAINE
N.H.
PISCATAQUA R.
PORTSMOUTH
NEW CASTLE
ROCKINGHAM COUNTY
RYE
FROST PT.
WALLIS SANDS BEACH
FOSS BEACH
RYE HARBOR
STRAW PT
JENNESS BEACH
RYE BEACH
BASS BEACH
NORTH HAMPTON
LITTLE BOARS HEAD
NORTH HAMPTON BEACH
HAMPTON
PLAICE COVE
NORTH BEACH
GREAT BOARS HEAD
HAMPTON BEACH
SEABROOK
HAMPTON HBR.
SEABROOK BEACH
N.H.
MASS.
ATLANTIC OCEAN
LEGEND
OWNERSHIP
FEDERAL
NON-FEDERAL PUBLIC
PRIVATE
USE
PUBLIC RECREATIONAL
PRIVATE RECREATIONAL
NON-RECREATIONAL DEVELOPMENT
UNDEVELOPED
NOTES:
1. Symbols along extensive shoreline length are connected by a line for drafting simplicity
2. Information shown by symbols has been generalized and is based on the best available data.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
NEW HAMPSHIRE
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
1
0
1
2 MI


KENNEBUNK
MATCH LINE A-A
WELLS
OGUNQUIT
YORK
YORK COUNTY
CAPE NEDDICK
YORK VILLAGE
YORK RIVER
YORK HARBOR
KITTERY
KITTERY POINT
PISCATAQUA RIVER
MAINE
N.H.
ATLANTIC OCEAN
CUMBERLAND COUNTY
SCARBOROUGH
SOUTH PORTLAND
MATCH LINE B-B
CRESCENT BEACH
PROUTS NECK
OLD ORCHARD BEACH
SACO
FERRY BEACH
CAMP ELLIS
SACO RIVER
HILLS BEACH
KENNEBUNKPORT
KENNEBUNK RIVER
KENNEBUNK
MATCH LINE A-A
ATLANTIC OCEAN
CUMBERLAND COUNTY
FREEPORT
YARMOUTH
PORTLAND
SOUTH PORTLAND
CAPE ELIZABETH
MATCH LINE B-B
CASCO BAY
ATLANTIC OCEAN
LEGEND
PHYSICAL CHARACTERISTICS
BEACH
NO BEACH
EROSION CONDITION
CRITICAL
NON-CRITICAL
NOTES:
1. Beach width not to scale.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
4. Cross hatched areas represent heavy urban development.
5. Non-critical erosion area is estimated as rocky or ledge outcrop for 30 percent of backshore south of Portland and 50 percent of backshore Portland to Kennebunk River. Accretion areas un-marked.
6. The remainder of the shoreline is shown on Plate No. 71. The shoreline east of Portland is not mapped in detail due to its complex configuration, but is discussed generally in report.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MAINE
SHORELINE CHARACTERISTICS AND EROSION CONDITION
SCALE IN MILES
1 0 1 2 MI.


CUMBERLAND COUNTY
CUMBERLAND COUNTY
N
KENNEBUNK
MATCH LINE A-A
WELLS
YORK COUNTY
OGUNQUIT
YORK
CAPE NEDDICK
YORK VILLAGE
YORK RIVER
YORK HARBOR
KITTERY
KITTERY POINT
PISCATAQUA RIVER
MAINE
N.H.
ATLANTIC OCEAN
SCARBOROUGH
SOUTH PORTLAND
CRESCENT BEACH
MATCH LINE B-B
PROUTS NECK
OLD ORCHARD BEACH
SACO
FERRY BEACH
CAMP ELLIS
SACO RIVER
HILLS BEACH
YORK COUNTY
KENNEBUNKPORT
KENNEBUNK RIVER
KENNEBUNK
MATCH LINE A-A
ATLANTIC OCEAN
FREEPORT
YARMOUTH
PORTLAND
SOUTH PORTLAND
CASCO BAY
CAPE ELIZABETH
MATCH LINE B-B
ATLANTIC OCEAN
LEGEND
OWNERSHIP
FEDERAL
NON-FEDERAL PUBLIC
PRIVATE
USE
PUBLIC RECREATIONAL
PRIVATE RECREATIONAL
NON-RECREATIONAL DEVELOPMENT
UNDEVELOPED
NOTES:
1. Remainder of coast from Portland to Canadian border not mapped in detail due to complex configuration of shoreline. Discussed generally in report.
2. Symbols along extensive shoreline length are connected by a line for drafting simplicity.
3. Information shown by symbols has been generalized and is based on the best available data.
4. Cross hatched areas represent heavy urban development.
NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MAINE
SHORELINE OWNERSHIP AND USE MAP
SCALE IN MILES
0
2 MI.



NOTE
1. Shoreline erosion, use ond ownership not mopped in detoil due to its complex configurotion, but is discussed generolly in report.

NATIONAL SHORELINE STUDY
NORTH ATLANTIC REGION
MAINE
COASTAL REACH
KENNEBEC RIVER TO CANADA
SCALE IN MILES
5 0 5 10